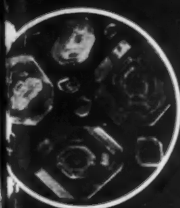


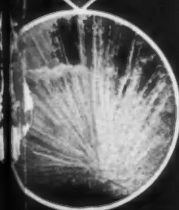
Read Hot Spot Sugar

CHEMISTRY

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Tattle-Tale Carbon

► **RADIOCARBON**, whose half-life is roughly equivalent to the era of written human history, is one of the most remarkable discoveries of our time. It is not a new substance. Cosmic ray bombardment in the upper atmosphere has created carbon 14 out of nitrogen throughout the life of our planet as we know it. Therefore we can measure the amount of radioactivity and rate of decay of radiocarbon in ancient carbon-containing materials and date their age with accuracy.

In another kind of research, newly activated carbon 14 from nuclear reactors can be incorporated into some of the myriad chemicals by which we live. Its course can be traced through the living body. The part played by each product in which it appears can be determined. Steps toward sharpening the focus of this detecting instrument are being taken by the research team headed by Dr. Horace S. Isbell at the National Bureau of Standards. They are described in this issue of **CHEMISTRY**.

Carbon 14 potentially can prove the exact mechanism by which food becomes fat and glycogen becomes muscle. It can trace what goes wrong in diabetes. The modification of normal growth which is cancer can be followed if we can incorporate this informative atom into the right chemicals. When a radioactive atom in the ribose molecule becomes available as a research tool, ribose can be converted into labelled desoxyribonucleic acid. This acid is found in cells, and is necessary for normal cell division.

There is the additional possibility of building chemical antidotes which will prevent the formation of cancer-causing conditions in the cells. The organic chemicals which make up the body seem to fit together molecularly, one compound forming and triggering the formation of the next. If the first harmful compound can be blocked by substituting an innocuous chemical for the cancer-causing one, the problem of cancer will be well on the way to solution and a new chapter in chemical therapeutics will be begun.

CHEMISTRY

Vol. 25, No. 8

Formerly The Chemistry Leaflet

April 1952

Including The Science Leaflet

Published monthly, September through May, by Science Service, Inc., the non-profit institution for the popularization of science. Publication Office: 119 South Frazier St., State College, Pa. Entered as second-class matter at the Post Office, State College, Pa., under Act of Congress of March 3, 1879. Address communications to the Publication Office; or to the Editorial Office: 1719 N Street N.W., Washington 6, D. C.

\$4 a Year; Two-Year Subscription \$7; Your Own and a Gift Subscription \$7 a Year. 50c a Copy. Ten or more subscriptions to the same address: \$2.90 a Year each. Subscriptions preferred for full volumes only, September through May inclusive; back copies sent. No charge for Foreign or Canadian Postage.

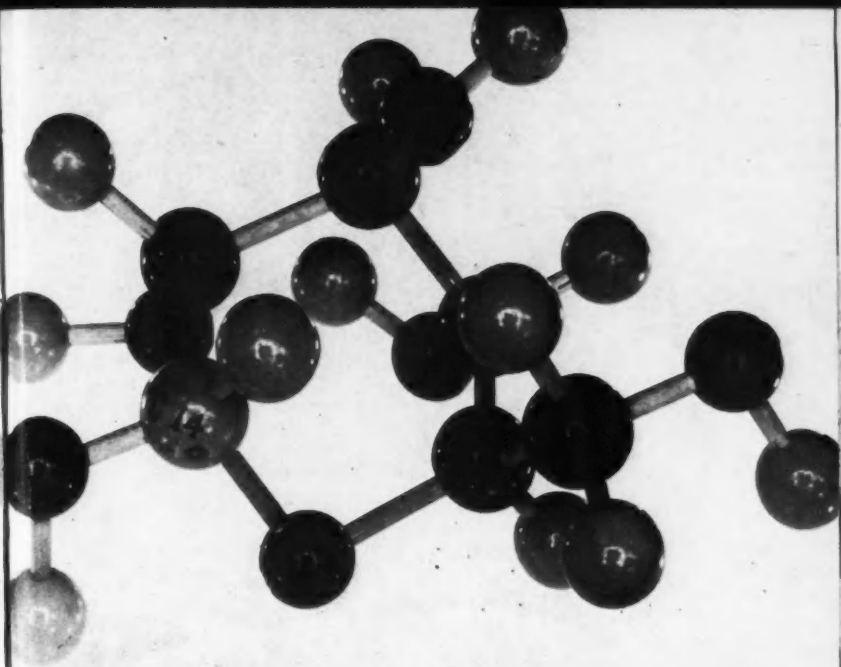
Editors: **WATSON DAVIS** and **HELEN MILES DAVIS**

Consulting Editor: **PAULINE BEERY MACK** (Editor 1927-1944)

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► THE CARBON 14 atom marked on this model of the glucose molecule is shown as part of the ring, next to the oxygen atom which has no side groups attached. The six atoms of the ring can be recognized, the carbon atom attached to No. 5, and the various hydrogens and hydroxyls joined to the carbon atoms. The positions of these groups above or below the plane of the ring account for the sixteen different kinds of sugars, each built of the same number of carbon, hydrogen and oxygen atoms.

Sugar With a Hot Spot

by HELEN M. DAVIS

► SUGARS are key chemicals formed by life processes. They appear as end products in the mystery of photosynthesis. They take part in the body's storage of nutrients and the nutrients' transformation into muscular energy. How sugars are formed in nature is

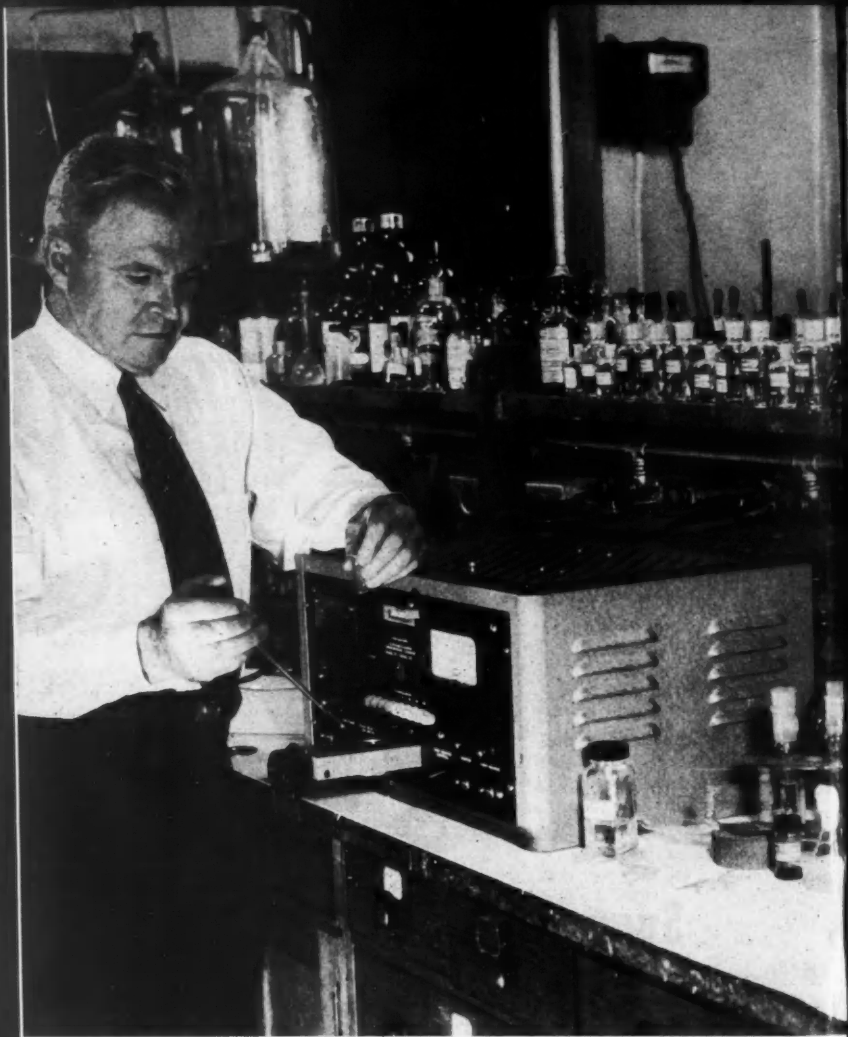
a secret the chemist would like to know more about.

It is important, therefore, to complete understanding of a sugar molecule to be able to follow the path of an individual carbon atom into and out of the sugar molecule in reactions in which it characteristically takes

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➤ DR. HORACE S. ISBELL puts a measured quantity of a known concentration of radioactive sugar dissolved in formamide into the counting chamber of a radiation counter. The sugars he makes, labelled by having radiocarbon in a definite position in the molecule, have an activity level of about one microcurie per milligram.



► DR. HARRIET L. FRUSH explains the use of the freeze-drier, to crystallize "hot" sugar, to three Eleventh Science Talent Search winners during a trip to the National Bureau of Standards.

part. Radioactive carbon 14 makes it possible to do this. The next problem is how to produce such a sugar, tagged with C-14 at a known position.

Sugars are simple chemicals. There are a number of them. The kind in the sugar bowl on your dining table is one of the more complex ones, since it is composed of two simpler kinds joined together. This ordinary sugar is called sucrose, and its formula is $C_{12}H_{22}O_{11}$. Its double molecule is rather easily broken in two to form two simpler sugars, dextrose or glucose and levulose or fructose. Glucose

is the most familiar of the simple sugars. Its formula is $C_6H_{12}O_6$.

The carbon atoms of glucose string out like a chain, with hydrogen and hydroxyl groups attached along the sides. But one of the oxygen atoms joins the carbon at one end of the chain to the next-to-last one at the other, curling the structure up into a ring. Differences in the positions of the carbon atoms and the geometry of the atoms attached to these carbons makes a difference in the properties of the resulting sugars. Even the taste and sweetness are affected.

Sugar which has one radioactive carbon atom among the six in its molecule, and that one in a specific place, is the product of researches now in progress at the National Bureau of Standards. Dr. Horace S. Isbell and Dr. Harriet L. Frush of the Bureau staff have made several such sugars, and have worked out the general method for making many more.

The radioactive carbon atoms they use came originally from the nuclear reactor at Oak Ridge, incorporated into barium carbonate. A commercial company processes this compound, and transfers the radioactive carbon atom to a molecule of sodium cyanide. In this form the Bureau of Standards buys it, in order to shift it into the sugar molecule.

In none of these transformations is it possible to have every carbon atom radioactive, or even the majority of them. When a radioactive carbon compound comes from the atomic pile, it is diluted with many times its weight of the same material made of ordinary C-12 atoms. This is because the ordinary kind had to be the carrier to remove the minute quantity of radioactive compound from the solution in which its transmutation took place.

When the carbon is transferred from barium carbonate (BaC^*O_3) to sodium cyanide (NaC^*N), again only a small fraction of the carbon atoms are radioactive ones. But atoms are very small, and there are enormous numbers of them in the milligram quantities Dr. Isbell and Dr. Frush use. They buy the cyanide on the basis of its amount of radioactivity.

To incorporate radioactive carbon into the sugar molecule, these re-

searchers take advantage of the fact that a pentose, a simpler kind of sugar containing five carbon atoms, will add a cyanogen group. The resulting compound is a six-carbon substance that can be converted into the corresponding sugar.

The complex geometry of the sugar molecule makes it possible to have sixteen different kinds of six-carbon sugars, but among the pentoses only eight different arrangements of H and OH around the five-carbon framework are possible. These eight sugars of five-carbon constitution are two forms each of arabinose and ribose, xylose and lyxose. These pairs are alike except for interchange of the hydrogens and hydroxyls, resulting in molecules that are mirror images of each other, like right and left hands. The sugars can be classified further into epimeric pairs. Epimeric pairs of compounds are often formed at the same time, and are difficult to separate.

To make sugar labelled with a radioactive carbon atom in the first position, Dr. Isbell and Dr. Frush start with the five-carbon D-arabinose. L-Arabinose occurs to some extent in nature. It is found in certain plant gums, especially cherry gum. This is the amber-like gum exuded by the wood of cherry trees. For the synthesis, D-arabinose is necessary and must be made by removing one carbon from glucose. D-arabinose has the proper structure to change into glucose when another carbon atom is added. Glucose is the form of radioactively labelled sugar most in demand.

Arabinose combined with radioactive cyanogen results in two epimeric



► SUGAR is put through the reduction apparatus by Miss Nancy Holt (left), preparatory to changing it into radioactive sugar. Mr. Benjamin Bruckner (right) purifies a solution by running it through an ion exchange column.

compounds called nitriles. Heated with water, these can be hydrolyzed to get rid of the nitrogen and form gluconic and mannonic acids, right-hand and left-hand derivatives of the six-carbon sugars glucose and mannose.

These epimeric pairs of compounds, in spite of having very similar chemical properties, are different substances. They are often used quite differently in the animal body. Some structures seem to have a profound preference for one rather than the other. Radioactive glucose and radioactive mannose are therefore two important research tools. But the researcher wants them separated. To do this, he must take advantage of very slight differences in the behavior of the two.

Dr. Isbell and Dr. Frush can separate gluconic and mannonic acids because it happens that barium gluconate crystallizes fairly easily, while barium mannonate is non-crystalline. When they add a solution of a barium compound, gluconic molecules are precipitated as white crystals. Mannonic ones stay behind in the syrupy liquid.

Having separated the two epimers, the barium must now be removed. This is done with ion-exchange resins.

Barium gluconate crystals are dissolved in water and the solution is run through a column packed with the appropriate resin. Out comes gluconic acid again, but this time the molecules are all alike.

Another resin column similarly takes the barium out of the left-over syrup. Mannonic acid trickles out of that column. Two organic acids, near relatives of the two desired sugars, have now been made. Each contains one radioactive carbon atom in the No. 1 position.

These acids are now treated separately to form the corresponding lactones. actones have cyclic molecules, very close structurally to sugars. Mannonic lactone, by way of compensation, crystallizes better than gluconic.

To explain another difference between the two lactones, it is necessary to understand the way the carbon atoms in the sugar molecule are counted. Counting begins with the carbon atom next to the oxygen atom in the ring. This is No. 1, and is the radioactive atom in the Isbell synthesis. The carbon atom next to it is No. 2, and so on around. No. 6 is the carbon atom attached as a side group to the No. 5 atom.

In glucose, the oxygen atom joins the No. 1 and No. 5 carbon atoms, and corresponding lactone has the same structure. But in counting the carbon atoms another system is used, starting with the No. 1 atom but counting those beyond it. By this scheme the No. 2 carbon atom is referred to as alpha, No. 3 as beta, and so on. Thus the gluconic lactone is called a delta-lactone. But mannonic is a gamma-lactone.

It is theoretically easy to reduce a lactone to a sugar. In practice the work is long and tedious, and the yield used to be small. Since the Bureau of Standards chemists have been working on the problem, they

have studied every step and condition of the reduction process. They have not only improved the yield but influenced the production of one epimer at the expense of the other.

The overall yield of both radioactive sugars, by their process, is about 65%, but of the sugar synthesized the yield may be 70% of either, accompanied by 30% of its epimer, at the choice of the synthesizer.

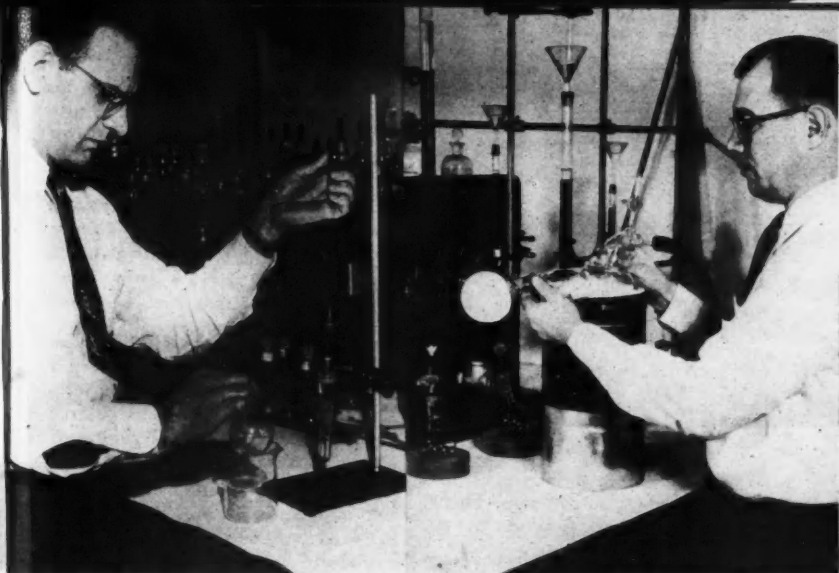
It has long been the custom of sugar chemists to reduce the lactone to sugar by means of sodium amalgam. "Quick silver" and reactive sodium combine to form a convenient alloy with much of sodium's combining power, modified so that it is less dangerous to handle. In the old days, sugar chemists would spread the amalgam out and cut it up like fudge, using large chunks for the reduction process.

In working with radioactive material, where both safety and cost demand micro-scale methods, the Standards research team had to revise the reduction method and the form in which the sodium amalgam could be employed more advantageously.

The sodium amalgam problem they solved by melting the material and dropping it down a reduced-scale "shot tower" into a pool of mineral oil, to form small pellets. These they store under mineral oil until ready to introduce them into the solution to be reduced.

Similarly, the sulfuric acid used on the macro-scale had to be replaced by something else better suited to micro quantities.

The reduction reaction has to be done in acid surroundings, in spite of the fact that one of the products is



► FILTRATION on the semi-micro scale is being carried on by Dr. Theodore Galkowski (left), separating sugar in solution from insoluble reagents. With the freeze-drier Mr. Joseph Moyer (right) can evaporate off as much as 500 cc of water from a sugar solution in a few hours.

sodium hydroxide. On a large scale this is accomplished by dropping in H_2SO_4 a drop at a time. On the micro scale this is not practical.

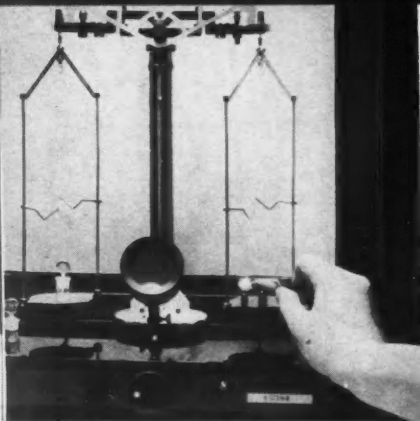
Dr. Isbell gets around this by using an organic acid, or an acid salt, only slightly soluble under the conditions present. As fast as the acid is neutralized more goes into solution. Benzoic acid and sodium acin oxalate are the two substances found most satisfactory to keep the cloak of acidity around the reacting lactone.

All the materials for the reaction—water, lactone, difficulty soluble acid and sodium amalgam—are dumped together into a specially designed tube and stirred vigorously while the reaction proceeds.

Before entrusting any of the precious radiocarbon to this routine, every step was carefully checked to make sure that the maximum yield had been obtained. More than 200 runs of this very laborious procedure were made by Dr. Frush.

After the sugar has been formed, the task remains of separating it from the sodium, the mercury, the salts and all the rest of the products mixed with it in the solution.

Here advantage is taken of the fact that sugar is soluble in alcohol while the other materials are not. Addition of alcohol to the mixture precipitates the salts. After these have been filtered off, the last traces left are removed by



passing the filtrate through a column of mixed ion exchange resins. This is the final step in purification.

The sugar solution that comes from the column is then concentrated by freeze-drying. This practically amounts to high-vacuum distillation. Sugar crystallizes out, and is re-crystallized from alcohol.

This first crop of sugar crystals does not exhaust the radioactive sugar from the liquids discarded along the way. They are re-worked to retrieve more of the labelled molecules. The well-known carrier technique, common to all work with radioactive materials, is employed here. Ordinary glucose is added to the residual liquids and, when it is reclaimed, a certain percentage of the radioactive glucose is found with it. This process is repeated several times. Each successive crop contains fewer of the radioactive molecules, but the product is still useful for research with tagged sugar.

Having mastered the technique of glucose and mannose tagged in the No. 1 position, Dr. Isbell and Dr.

► *TINY weighing bottles hold the final quantities of radioactive sugar prepared by Dr. Isbell and his associates at the National Bureau of Standards. These precious samples are now ready for shipment to research laboratories, to help scientists' understanding of the role sugar plays in life processes.*

Frush are now working on other sugars. Each new sugar behaves a little differently. Each involves a separate research project to find out the conditions necessary for labelling each epimeric pair of sugars.

There is also the problem of labelling other carbon atoms than the one in No. 1 position. The research team has already made some progress on that one. To get the radioactive carbon atom into the second position it is necessary to start with a four-carbon sugar.

Two sugars containing four carbons each are possible, the dextro- and laevo- forms of erythrose and threose. They are syrupy, non-crystalline substances which most chemists would rather not work with on account of their indefinite characteristics.

By repeating essentially the same process that they use for making glucose out of arabinose, Dr. Isbell and Dr. Frush are able to get radioactive arabinose from erythrose. Its epimer ribose is formed at the same time, a sugar which is very important in life processes. Eventually the Bureau of Standards team expects labelled ribose to become a research tool of outstanding importance.

At the present time the work in progress is production of glucose with

the radioactive carbon atom as No. 2 of the ring. From arabinose, the 5-carbon sugar, labelled in the No. 1 atom, they make glucose by the process outlined above. But this time ordinary carbon 12 is used for the synthesis. Since the new carbon atom adds onto the end of the carbon chain, this results in glucose with the radioactive atom in the second place.

Every additional manipulation of the radioactive material doubles the

labor and cuts the yield, but eventually Dr. Isbell and Dr. Frush hope to be able to supply research laboratories with doubly labelled glucose and radioactive ribose.

With these, many questions concerning nutrition, growth, cell structure and other life processes will have the possibility of a direct answer, as researchers will be able to trace the individual parts of the sugar molecule through their gyrations among the living cells.

On the Back Cover

- POOR sugar crystals, such as these, form spontaneously, growing out from many centers and occluding much of the liquid from which they form. The resulting mass is moist and lumpy, like brown sugar, instead of the dry, shining crystals which the art of the sugar refiner is able to produce for table use. Crystals of radioactive sugar have a texture in between these two extremes.

Desalting Processes Interest Several Chemical Industries

Fresh Water From Ocean Possible

► FRESH, drinkable water from brackish sea water is a realizable dream for the near future through the use of ion exchange films or membranes and the application of differences in electrical potentials.

Whether the costs of such operation can be reduced to a level where the process can be used to supplement existing water supplies for cities is a matter for future development.

Several organizations are working on this problem, among them Rohm and Haas Co. in Philadelphia, Ionics, Inc., of Cambridge, Mass., Dow Chemical Co. at Midland, Mich., and the University of California at Los Angeles.

Already there are ion exchange resins in granule form that can be used to desalt water and perform dozens of other extractions of chemical substances from liquids. But the quantities handled are small and the costs high.

The new developments consist of use of the plastics or resins in sheet or membrane form, with the use of electric power to aid the process of dissociating the sodium chloride, which is salt, in such a way that it can be removed.

The federal Reclamation Service in Washington has been urging Congress to make \$25,000,000 available for developmental desalting water research, and such legislative request has been cut to \$2,000,000 in hearings held recently. If such appropriations were made, experiments with some of

the ion exchange methods would be made.

The latent energy of salt, which is the minimum of energy necessary to separate its chemical components, is three kilowatt hours per thousand gallons of sea water. A possible figure of 10 to 20 cents per thousand gallons was given by the Cambridge group of Ionics division of the American Research and Development Corporation, closely associated with Harvard and Massachusetts Institute of Technology staff members. This is a reasonable figure for the future with very cheap electrical power available, yet it is a tenth of the best possible costs worked out by the most promising distillation methods.

Since even water from a river is not obtained without cost, these possible costs of desalted water bring the process to within reach of the cost of reclamation and industrial water which often costs as much as the estimated ion exchange water costs.

To obtain large output of water by the ion exchange method might require an excessive investment in equipment. The slower the process the less electrical energy is used, yet it may be advantageous to waste electricity to reduce the number of expensive units installed.

Details of the exact methods used are being kept secret due to filing of patents. The chemical nature of the resins used is also unannounced. If the process seems vital to defense activities, it may be kept secret by government order.



► "ARE YOU sure that was the coffee pot you plugged in?"

**Pain Relieving Alkaloid
Made by Complicated Process**

Morphine Synthesized at Last

► THE COMPLETE synthesis of morphine, pain-easing drug of the opium poppy, has been accomplished by Dr. Marshall Gates of the University of Rochester, New York.

Announcement of this feat, in which a Swiss girl, Gilg Pschudi, assisted, appeared in the *Journal of the American Chemical Society*.

The achievement, in the words of one chemist, marks "the last great mountain peak to be surmounted" in man's long struggle to synthesize the alkaloid chemicals found in plants. Only exception, now, is strychnine and no one is believed too interested in synthesizing this drug. Among other alkaloids found in plants are caffeine, nicotine and quinine.

Synthesis of morphine does not mean a cheap source of the chemical, for drug addicts or legitimate users. Synthetic morphine could not be made for \$1,000 a gram, which is about one-thirtieth of an ounce or about 20 grains. On the legitimate market, one grain of morphine extracted from the poppy plant source costs about five cents and would sell at retail to the

patient for about 10 cents a grain, though usually it is dispensed in quarter or half grain doses.

The process by which Dr. Gates and Miss Pschudi succeeded in synthesizing the drug is extremely complicated, requiring some 20 to 30 steps. Probably only 10 or a dozen chemists in this country could follow it. Dr. Gates has been working on the problem for more than 10 years. Swiss and German chemists are hard at work on the problem, also.

Some of the intermediate chemicals used in the synthesis were made in the 1930's by Dr. Leonard H. Small of the National Institutes of Health. Dr. Small at that time was trying to make a synthetic chemical that would duplicate morphine's pain-relieving effect without addiction properties. He did not realize that some of the chemicals he made would later facilitate the synthesis of morphine itself.

The synthesis is a tremendous scientific achievement, but is not expected to have any practical follow-up. The reason is that there are now better chemicals which are easier to make for use instead of morphine.

By-products Sterilize Antibiotics

► ATOMIC ENERGY by-products are being tried out as sterilizers of the modern "miracle drugs," such as penicillin, streptomycin and others. If this proves practical, it will simplify the sterilization of the drug.

The idea is "wonderful" and Food and Drug Administration officials

hope it works, Dr. Henry Welch, head of the FDA's antibiotics division, said at a Stanford Research Institute sponsored conference on the subject in Washington. He warned, however, that manufacturers must not leave anything in the antibiotics that would be harmful to users.

Antabuse Discoverer Gives Three Views of Alcohol

Chemistry of Alcohol in the Body

► PEOPLE who like their liquor should take vitamin pills to avoid the fate of "drinker's liver," Dr. E. Jacobsen, Danish scientist discoverer of the alcoholism-curing drug, Antabuse, declared at a meeting at London University recently.

Dr. Jacobsen pictured alcohol in three different lights: arch-villain, hero, and innocent victim of malicious slander.

Leaving aside the social aspects of alcoholism, alcohol takes on the role of villain because of the ready way in which it supplies the body with a large number of extra calories. The human body is able to burn up enough alcohol each day to manufacture 1,200 calories, which is almost half the total required by the average office worker. Because of this a good deal of food a drinking person eats is not burned up but stored away as rolls of fat.

Some heavy drinkers react to the calories supplied by the alcohol by cutting down on the amount of food they eat. This usually leads to a vitamin deficiency, particularly of the B vitamins. That is where the slander and vitamin pills come in.

The slander involved is the commonly repeated story of cirrhosis and fatty degeneration of the liver supposed to be caused by the "poisonous" effects of alcohol. Dr. Jacobsen does not believe there is a shred of truth to this talk about alcohol being a liver poison. One of the functions of the liver, he says, is to burn up alcohol.

This it does quite passively through enzyme action, so that drinking alcohol does not directly harm a good liver; nor does abstinence, so commonly prescribed in liver disorders, particularly help a bad one.

The cirrhosis and degeneration of the liver often found in chronic alcoholics is only indirectly due to the liquor these people consume. The conditions are brought about by the dependence of the drinkers on vitamin-lacking alcohol as a calorie substitute for vitamin-containing foods.

But even alcohol can be a hero and this it is in cases of poisoning by wood alcohol—"smoke," in the addict's jargon—which can kill a person or leave him permanently b'ind. Wood alcohol in itself is not poisonous, but in the body an enzyme turns it into formic acid, which is extremely so.

Formic acid is not burned in the body. It must be excreted and as its excretion is slower than its formation from the wood alcohol, a poisonous amount soon accumulates in the body.

The only possible way to stop the poisoning is to cut down the rate of transformation of "smoke" into formic acid. Grain alcohol (ethyl alcohol to chemists, just plain "alcohol" to the layman) is the only substance so far known which can turn this trick. When burned in the body alcohol can make use of the same enzyme needed by the wood alcohol. By giving the sufferer large doses of alcohol doctors can tie up most of the enzyme with

the latter, leaving only a little enzyme free for the wood alcohol. In this way the rate of formic acid formation is cut down to a snail's pace and the body can eliminate it as fast as it is formed.

Once in the blood stream alcohol is eliminated by most people at a steady, unalterable pace of about one-quarter ounce per hour. Exercise doesn't make the slightest particle of difference, so that the time-honored treatment of walking an inebriated person round and round is just a waste of good time and energy. Even injections of insulin do not alter the rate of alcohol elimination.

Dr. Jacobsen did, however, give scientific support to the notion that mixed drinks are less intoxicating than straight liquor. Experiments have shown that, other things being equal, the lower the concentration of alcohol

in a drink the more slowly is it absorbed into the blood. This naturally slows the accumulation of alcohol in the blood and retards onset of inebriation effects.

Explaining how his drug, Antabuse, discourages people from drinking, Dr. Jacobsen showed how alcohol is burned by the body first to form acetaldehyde and then to form acetic acid, the vinegar acid, the latter being readily consumed by the body in its normal metabolism. When a person takes Antabuse the drug partially blocks the conversion of acetaldehyde to acetic acid. The acetaldehyde then accumulates in the blood and makes the person nauseated. Consequently, the alcoholic with sufficient determination to take his Antabuse tablet regularly has strong encouragement to keep away from that "one drink" which otherwise becomes his downfall.

Radioactive Gold Gives Double Benefit

► CANCER patients get double benefits from radioactive gold.

It slows down the growth of the cancer cells themselves. It also slows down the secretory activity of normal cells lining body cavities.

When cancer has spread from its original location to some body cavity, excess fluid is produced by normal lining cells of the cavity, Dr. Shields Warren of the Atomic Energy Commission explained to the American Association for the Advancement of Science. This may be a very troublesome symptom. Radioactive gold relieves it.

The radioactive gold is used as a colloid and either injected into the cancer mass or into one of the body cavities.

Radioactive gold, radioactive cobalt, radioactive phosphorus and radioactive iodine are the four radioactive isotopes showing most promise as medicines, Dr. Warren indicated. As a whole, he said, the radioactive isotopes have proved disappointing in cancer treatment, though they are useful for diagnosis and for giving new information about processes in the body including cancer.

How Virginia Tests for Poison

Reprinted from the Bulletin of the Virginia Sections of the American Chemical Society

by SIDNEY KAYE

In 1946 the State Legislature proposed and passed a bill establishing a medical examiner's system for the Commonwealth of Virginia to replace the antiquated coroner's system that still prevails throughout most of the United States. The law is clear and definite in its organization and one of its prime purposes is to determine clearly and accurately the nature and cause of deaths, especially those occurring under suspicious circumstances. Toward this end a toxicology laboratory has been set up to aid in differential diagnosis in questions of poisoning.

► ABOUT one-tenth of all deaths investigated by medical examiners are likely to be the result of poisoning as shown by figures from the areas having adequate toxicological facilities. It becomes the responsibility of the toxicologist to produce *quantitative* proof that a specific drug or poison caused or contributed to death, since the changes produced by most poisons on various body tissues are primarily biochemical rather than anatomical or are of such character that the causative agent cannot be determined by pathological examination. In clinical medicine where therapeutic agents may exhibit deleterious or even fatal effects, the poison is known and the demands upon the toxicologist are less exacting, but in medico-legal investi-

gations it is essential that the poison be specifically identified and quantitatively determined or be completely excluded. There can be no margin for error; rigid precautions and the most exacting micro-technics must be employed.

A thorough knowledge of the origin of the various poisons (both common and uncommon); properties, physiological actions, signs and symptoms produced; toxic and lethal doses; the appropriate methods of extraction from biological materials, purification, detection and quantitative determination; interpretation and evaluation of the results aid immeasurably in arriving at an accurate conclusion. When the facts are determined they must be made to stand up for themselves.

Poisonings usually are a result of:

Accidents (at home, especially with children)

Occupational (industrial fumes or dust)

Suicides

Homicides

Careful analysis and evaluation is essential to help identify and differentiate one situation from another. Several case reports from personal files will help to illustrate this point:

Case No. 1

While in service a young husband returned home unexpectedly one weekend to find his wife entertaining

a boy friend in a most unladylike situation. The friend promptly made his exit and a quarrel between husband and wife ensued. Since this was not the first occasion, he informed her of his intention to leave and obtain a divorce. The wife persuaded him to remain with her for one last evening and have a "last fling" celebration. Together they made the rounds of several taverns. The husband died shortly after they arrived home. Analysis indicated a high concentration of alcohol in the brain, but not an amount sufficient to account for death. Further studies revealed large amounts of chloral hydrate (in lethal quantities) throughout the various organs. Upon interrogation when confronted with this evidence, the wife confessed poisoning her husband.

Case No. 2

A burning shack in the outskirts of town attracted attention and fire service was called. Among the rubble a dead man with extensive burns was found. Papers in his pockets identified him and further investigation disclosed that he was a vagrant well-known in town as a chronic alcoholic. Blood was drawn from his heart and on analysis was shown to contain 0.21% alcohol. The police were first inclined to sign this case out as accidental; a drunk kicking over a lamp in a deserted cabin, or falling asleep with a lit cigarette. However, as is routine in all burn cases, a blood carbonyl hemoglobin level was determined and it was found that the blood contained less than 1% carbon monoxide, which is normal. Incident to every fire there is an abun-

dance of carbon monoxide, and every person dying as a result of burns caused by fire in closed quarters *always* has some carbon monoxide in combination with hemoglobin. This value ranges between 18% and 70% carbonyl hemoglobin saturation. In the higher levels (above 50%) carbon monoxide may be considered the lethal agent. But the presence of carbon monoxide even in smaller amounts indicates that life existed during the fire. Here no abnormal CO was found which indicated that the decedent was dead when the fire was started. An autopsy was then performed and several stab wounds were evident. Cause of death was found to be a stab wound to the heart and hemorrhage. A careful search of the surrounding grounds showed suspicious strains about 75 feet away from the shack. This on testing proved to be blood of human origin belonging to the same blood group as that of the decedent. The soil depth that the blood penetrated and the area it covered showed it to be in excess of 3 quarts (This was experimentally duplicated with similar soil and 3 quarts of blood). The modus operandi and scene were now established. With this information the police were able to further establish that the decedent was near the shack with an old drinking companion. A quarrel ensued and one stabbed the other. In an attempt to camouflage this murder, the decedent was carried into the shack whereupon it was set afire. A dead man was burned. A simple carbon monoxide level turned an accidental death into homicide.

Case No. 3

A young man was hospitalized with a fractured hip bone. The bone was set and he was immobilized. This lack of movement produced bed sores, some developing into open ulcers, which were swabbed with merthiolate. After several weeks the patient began to develop stomatitis, abdominal pain, oliguria, albuminuria, and diarrhea. This was attributed to an intestinal disturbance, but he kept getting worse. The oliguria progressed into anuria, the diarrhea was now complicated with ulcerative colitis and he sloughed off approximately 25 grams of his lower bowel mucosa. This was a disturbing development, so an analysis of his blood, urine and sloughed off bowel mucosa was ordered. These revealed abnormally high values for mercury. The search was on—where and how did he get exposed to mercury? It was then noticed that he was painted with merthiolate and the several open ulcers were packed with impregnated cotton and held in place by adhesive. Merthiolate is approximately 50% mercury (Sodium ethyl mercuri-thiosalicylate). The open ulcers permitted open passage. With removal of the exposure, the patient had a slow but uneventful recovery with the aid of B.A.L.

Case No. 4

A middle aged night janitor was found dead one morning in a chemical plant. At first it was thought that he died as a result of some noxious gases that may have been generated while he was working around the plant. This was tentatively confirmed when cyanide was found in lethal

levels in his blood. A distribution study of the various organs was undertaken and it was found that the lungs contained but small quantities of cyanide whereas the stomach contained large quantities of potassium cyanide not yet absorbed. Cyanide poisoning is a rapid death and usually kills within 5 minutes. This disproved the inhalation of noxious fumes and put some credence to a strong possibility of suicide.

Case No. 5

It is generally believed that some drugs even when taken in excess are innocuous. Such is not the case. Anything may be poison if taken and absorbed in sufficient amounts. Our experiences even include such bland drugs as aspirin, alcohol and therapeutic ferrous sulfate.

A three-year-old child inadvertently ingested 30 Feosol tablets. Within 30 minutes abdominal pain, nausea, vomiting, and diarrhea developed. Within the hour the diarrhea developed into bloody diarrhea with additional evidence of internal hemorrhage and generalized shock and collapse. Transfusions were attempted but to no avail. Death followed cardiovascular collapse.

Case No. 6

A small colored boy 8 years old was admitted to the hospital with symptoms of pain in the joints, nausea, vomiting, abdominal pain (but no diarrhea), muscular tremors, and occasional twitching. Originally he was diagnosed as having rheumatic fever but when he did not respond to treatment a brain lesion was con-

sidered. In the meanwhile he failed to recognize anyone, could not eat and lost sphincter and muscular control. He continued to get worse and lost all of his hair. A urine and blood analysis showed large amounts of arsenic. B.A.L. antidotal therapy was instituted and maintained for several days. The patient seemed to respond and started to rally. One month later (at this writing), patient recognized other patients and doctors, ate well, regained muscular and sphincter control and was even regrowing his hair. During that month, an investigation revealed that he worked after school in a large drug store where he had picked up from the floor and eaten some sugar coated peanuts. These peanuts were liberally sprayed with arsenic trioxide that had been used as a rodenticide.

Toxicological Analysis

The actual testing for poisons presents no great difficulty for the expert if the poison is present in moderate amounts, but considerable skill and experience are required in separating poisons from extraneous materials and in purification before specific tests can be applied.

It is impractical to describe here the various separation methods employed to isolate poisons since they vary with the nature of the materials. For most practical purposes the general scheme and modifications of Stas-Otto is still used for the isolation of many of the common poisons; for speed and conservation of material, some of the common poisons are divided into several groups and the isolation is performed serially.

1. *Volatile*: Alcohols, acetone, aldehydes, camphor, aniline, benzene, nitro-benzene, phosphorous, ether, chloroform, cyanides, carbon disulfide, phenols, pyridine, chloral, etc.

2. *Acid ether soluble*: Barbiturate derivatives, salicylates and derivatives, benzoic acid, caffeine, cantharides, acetanilide, phenacetin, picrotoxin, sulfonal group, etc.

3. *Alkaline ether soluble*: Alkaloids in general such as atropine, cocaine, codeine, quinine, brucine, strychnine, aconitine, etc.

4. *Ammonia ether, chloroform (ethyl acetate) soluble*: Morphine, theobromine, apomorphine, etc.

5. *Heavy metals*: Lead, bismuth, cadmium, antimony, arsenic, mercury, thallium, zinc, etc.

Testing for these five main groups is usually adequate for the isolation of many of the common poisons. However, it must be remembered that even some of these require special treatment (aniline, phosphorus, ether, chloroform, cyanides, methyl bromide, etc.), or they may be missed.

Still many others such as fluorides, carbon monoxide, radio-active agents, fluoroacetate, toxalbumins, metrazol, D.D.T., glucosides, benzedrine, etc., are analyzed by particular methods and techniques. Toxicological examination of biological material is work for an expert and should never be undertaken except by those having specific training and experience. The rough qualitative testing sometimes attempted by those without instruction or experience in forensic chemistry is injudicious since it wastes irre-

Materials Best Suited for Toxicological Analysis

<i>Specimen</i>	<i>Minimum Amount</i>	<i>Poison for Which Best Suited</i>
Urine	All available	In nearly all types of poisoning.
Stomach contents	All available	In which poison is known or thought to have been taken by mouth within a few hours.
Intestinal contents	All available	For cases in which poison was taken by mouth within one or two days.
Blood	At least 10cc (preferably 200cc)	All gas poisons, methemoglobin, sulfonamides, bromides, drowning test, and many other poisons.
Brain	500 grams	Volatile poisons, barbiturates, alkaloids, acute alcoholism, etc.
Liver	300 grams	Metals, barbiturates, fluorides, oxalate, sulfonal, and many other poisons.
Kidney	One kidney	Metals, especially mercury, sulfonamides.
Bone	200 grams	Lead, arsenic, radium (especially chronic).
Lung	One lung	For inhaled poisons (proof of entry).
Hair, Finger and Toe Nails	5 grams	Chronic arsenic poisoning.
Muscle	200 grams	In most acute poisoning, and when internal organs are badly putrefied.

placeable material and may lead to an erroneous result.

Where poison is suspected of having caused or contributed to death, the demand on the part of integrated medicolegal investigation for scientific chemical proof can be met best by providing the toxicologist as soon as possible with full information and adequate amounts of the proper material suitably collected and preserved.

Preservation of Specimens

It is essential that the toxicologist be supplied with an adequate amount of material placed in chemically clean, glass covered containers. All specimen jars should be sealed in a distinctive manner so that any tampering with the material will be evident immediately. Specimens should be locked in a refrigerator until shipped or otherwise delivered to the toxicologist. The continuity of possession must not be broken, for if

continuity of possession cannot be shown, the material becomes valueless for medicolegal purposes. A receipt with the date and hour indicated should accompany all transfers.

Specimens should be delivered shortly after first being obtained and the autopsy should be performed before the embalming of the body since formaldehyde interferes with tests for cyanides, methyl alcohol, phenols, carbon monoxide, and alkaloids, and hardens the tissue to such an extent that other analyses are difficult. When a chemical preservative must be used, 95 per cent ethyl alcohol is to be preferred except, of course, where a determination for ethyl alcohol is indicated. In all cases, a sample of the preservative used should be submitted so that it can be analyzed for foreign substances.

Where accident or suicide by poison has been a matter of legal dispute, the records show that in many cases no effort has been made to show that poison was the actual cause of death!

Leads and Clues

From the standpoint of the toxicologist it is indispensable that he have certain preliminary information for several reasons:

1. Attention can be concentrated on certain groups of poisons.

2. Large numbers of time-consuming analyses can be avoided, and limited material can be more efficiently utilized.

3. Leads and clues can be obtained from:

- a. Circumstances surrounding the death or illness,

- b. Symptoms and behavior before death, and

- c. Gross and microscopic autopsy findings.

It is essential to know the first appearance of symptoms of death after taking last food or drink, the nature and intensity of these symptoms, whether or not there was vomiting, deep sleep, tingling of skin and throat, convulsions or twitching of the muscles, delirium, dyspnea, contraction or dilation of pupils, changes in vision or hearing, etc., in addition to any evidence found at the scene. The autopsy findings aid in eliminating or considering certain poisons with selective effects on the various tissues.

The symptoms and behavior of the patient may be of great help in excluding or taking into account large groups of poisons which probably would or would not be present.

The state toxicological laboratory has additional duties in rendering scientific assistance to the Chief Medical Examiner and the 300 medical examiners geographically located throughout the state in questions of violence other than poisons. To illustrate some of these situations a brief paragraph might suffice to describe a few of our activities during the past months.

1. A waxy mass found floating in a well was identified to be adipocere (human). It was then later presumed to be the farm hand who had suddenly disappeared 5 years ago.

2. Identification of marihuana cigarettes.

3. Microscopic comparison of clothes threads and spectrographic analysis of paint scrapings in a hit and run accident resulted in identification of auto.

4. Test firing of a rifle to prove that the wound was a contact wound which could have been self-inflicted (suicide).

5. Post mortem identification of seminal fluid and spermatozoa (rape).

6. Establishing the facts in drowning (death occurred after submer-sion).

7. Establishing the facts in many drunken driving cases involving fatal automobile accidents.

8. Hammer found in possession of suspect contained blood of human origin, was later proven to be murder weapon.

9. Identification of heroin in what was alleged to be aspirin.

In less than five years the state toxicology laboratory has built up its facilities and staff and now processes annually more than 1,400 cases.

For the Home Lab

Lecithin from Eggs

by BURTON L. HAWK

► LECITHIN is a greasy, waxy substance belonging to that large variety of fats and related compounds known as *lipids*. There are *simple lipids*, such as butterfat; *compound lipids*, such as lecithin; and *derived lipids*, such as the fatty acids and sterols.

Lecithin is widely distributed in nature. It is present in the human body in the brain, kidney, liver, heart, lung and spleen. It is also found in egg yolk and soy beans.

Since it is rather inconvenient to separate lecithin from the brain, heart, kidney or lungs, we shall attempt to extract it from egg yolks.

First, it is necessary to hard-boil an egg. We suggest that you consult a good cook book to determine how this is done. Place about one-half of the yolk in a mortar. Add 30 cc. of ether, small portions at a time, and

grind until a smooth liquid is formed. Quickly filter and wash the filtrate with additional ether. Then transfer the filtrate to a watch glass and evaporate off the ether by floating the glass in a container of hot water. Be very careful in working with ether, as it is highly inflammable and its vapors can be explosive. Make certain that no open flames are in the room and that adequate ventilation is provided.

Ether will dissolve lecithin from egg yolk. But along with the lecithin it also dissolves a certain amount of fat and protein. So our next step is to remove the fat and protein from our residue. This we can do by extracting with alcohol. Alcohol will dissolve the protein and part of the fat, but not the lecithin.

Dissolve as much of the residue as possible in 10 cc. of hot alcohol.

Allow to stand a short time, then carefully pour off the alcohol from the heavy oil. Evaporate the remaining liquid off by applying gentle heat. Do not heat strongly. The remaining residue should consist primarily of lecithin along with a portion of the fat. Dissolve it in 6 cc. of ether and add an equal quantity of acetone. The fat is soluble in acetone, whereas the lecithin is not. The latter will separate in small particles. By stirring with a glass rod, you should be able to get these particles to adhere together and form a waxy ball.

Detection

You can perform a delicate test for lecithin just to verify that your lecithin is lecithin. Dissolve a small particle of the lecithin in 1 cc. of ether. Shake this solution with 2 cc. of a 10% solution of ammonium molybdate (approximately one gram of ammonium molybdate dissolved in 10 cc. of water). Now *very carefully* float a portion of this solution on one cc. of concentrated sulfuric acid in a test tube. A red ring will form where the two liquids meet which will rapidly turn to green and finally to blue.

Properties

Lecithin will not dissolve in water, but will swell up to form a milky colloidal solution. Drop a small piece of lecithin in water and add a pinch of salt. Stir, and note the swelling of the granules.

Prepare a solution of sodium hydroxide by dissolving one gram of the solid in 10 cc. of water. Boil a piece of lecithin the size of a pea in this solution for a few minutes. Do you observe any indication of a soap being formed?

* * * *

Lecithin is quite a complex fatty substance. It is a mixture of the diglycerides of palmitic, stearic and oleic acids linked to the choline ester of phosphoric acid. (*Wow!*)

When it is hydrolyzed it splits up to form acids, choline, phosphoric acid and glycerol. It is known more technically as a *phospholipid*, which means it contains phosphorus and nitrogen in addition to the usual carbon, hydrogen, and oxygen.

Lecithin is important in the role of an emulsifying agent, and is used in the preparation of margarine, salad dressings and similar products.

Chemical Explodes at Ordinary Heat

► A CURIOUS chemical that explodes at ordinary temperature and reacts with everything organic has been isolated by Drs. Alfred Engelbrecht and Aristid V. Grosse of Temple University's Research Institute at Philadelphia.

Although this purple-vapored green solid and liquid, permanganyl fluoride in chemical composition, was actually first made over a hun-

dred years ago by the German chemist Wöhler, it had not previously been prepared in its pure state.

The Temple chemists used silica-free glass and transparent plastics in their manufacture of the chemical, which corrodes ordinary glass and quartz.

If it is kept at dry ice temperatures, the compound does not explode.

Ion Exchange

Reprinted from Research for Industry, Stanford Research Institute, Stanford, Calif.

► IN CHEMICAL processing the engineer is almost always confronted with the necessity of a purification step or the removal of unwanted material from that desired. In some cases, several pure materials are sought, and the problem is then one of separation rather than purification. Many of the unit operations the chemical engineer uses are intended for just such purposes—crystallization, distillation, filtration, and solvent extraction, to name several—and have served well.

Recently, however, a new and versatile unit operation, ion exchange, has become available for the purification of solutions involving ionizable substances. These materials differ from nonionized solids, such as sugar, in that they break up into ions of two types: one is positively charged and called a *cation*; the other is negatively charged and called an *anion*. For example, common table salt (sodium chloride) breaks up in water solution to yield the sodium cations and chloride anions.

Nearly a hundred years ago it was found that cations in surface water would exchange with bound cations in siliceous materials, such as natural zeolites, in the soil. It was also found that this exchange was reversible; that is, it was possible to restore the original ions of the soil, after its activity had been exhausted, by treating them with a solution containing such ions. This principle was put to industrial

use about fifty years ago when natural zeolites containing sodium ions were used to soften hard water. Much later, in the middle 'thirties, it was found that these ion-exchange materials (whose principal characteristics are great insolubility and the presence of exchangeable sites in the solid structure) could be made synthetically in a manner similar to organic plastics. In addition, it was found that resins could be made that would exchange anions also, so that both types of exchange were now possible.

Ion exchange may therefore be defined as "the reversible interchange of ions between a liquid and a solid involving no appreciable change in the structure of the solid."

Demineralization of Water

The mechanism of cation exchange can be illustrated by its use in water softening. In the softening step, the calcium, or hard, ions in the water are replaced by the sodium, or soft, ions of the resin. The exhausted resin can then be regenerated with common salt so that the calcium ions now on the resin are again replaced by sodium ions. If, instead, an acid, or hydrogen-form, resin is used in the softening step and the resulting solution is then treated by an anion exchanger, the acid of the anion is picked up by this second resin and the water is thus completely demineralized to the point of distilled-water quality.

The industrial usage of this unit operation has greatly multiplied since the development of the synthetic resin ion exchangers, because of their high exchange ability and their good chemical and physical stability to the innumerable cycling between exhaustion and regeneration. As pointed out above, one of the major uses is in water softening. (Los Angeles city water is a blend—part of it is softened by ion-exchange resins and mixed in about one-to-one ratio with reservoir water before distribution through city pipes.) Another important use is in the beet-sugar industry, where the process of liming to purify sugar has been aided by the advent of ion exchange so that the

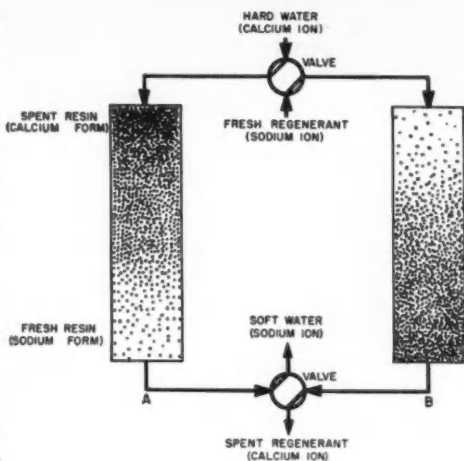


FIG. 1

final impurities are removed from the sugar juices, increasing sugar and decreasing molasses yields and making it possible to produce an edible liquid sugar directly.

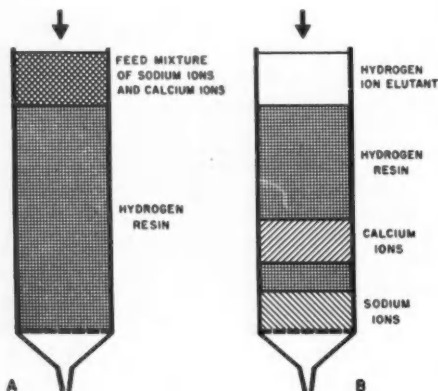


FIG. 2

Ion exchange has also found its way into many other fields, in such processes as corn-syrup refining, recovery of sugar from pineapple mill juices, removal of calcium from milk in the preparation of a soft-curd variety, purification of streptomycin, recovery of chromic, phosphoric, and hydrochloric acids used in metal treating, and deacidification of various earth elements and of amino acids, catalysts, and numerous others.

Low Temperatures

In the main, it is used at relatively low temperatures, normally not above 100 degrees Fahrenheit, and for solutions of relatively low concentrations. This limitation is imposed principally by the capacities of the exchangers, since as the electrolyte concentration increases, the volume of the solution which may be treated before exhaustion of the exchanger decreases until eventually a point is reached where the volume of liquid treated is less than that of the exchanger.

Because ion exchange involves reaction between a liquid and a solid the primary function of any equipment used for this purpose is to bring the reaction components into

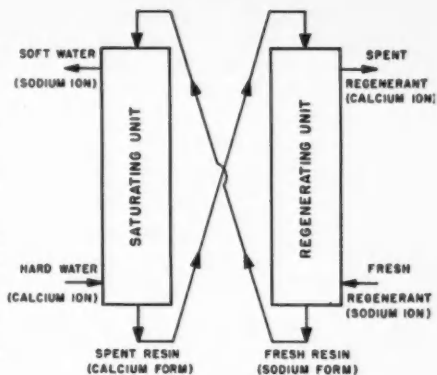


FIG. 3

intimate contact so that the exchange of ions may take place. In the past, the most common method to accomplish this was to pass the liquid through a container, more commonly known as a fixed bed of ion-exchange granules.

Another method, more versatile in that it lends itself to continuous operation—the counter-current contact of moving resin and solution streams—has been under study at Stanford Research Institute for some time.

The normal *fixed-bed* operating cycle for ion removal is comprised of four steps: (1) reaction between exchange bed and raw liquor, (2) backwash of the bed to remove dirt and to regrade the bed, (3) regeneration of exhausted exchanger by passing regenerant solution through bed, and (4) rinsing the bed free of regenerant. The bed is then ready for the next cycle. To insure continuous flow of liquor, at least two units are usually

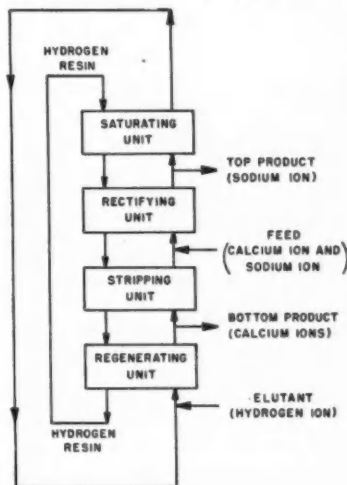


FIG. 4

provided in the semicontinuous operation. At a given time, one unit is on-stream while the other is being regenerated. This type of operation is shown in Figure 1. Here the degree of shading indicates the amount of calcium picked up by the resin. After bed *A* is almost all converted to the exhausted form (calcium) and bed *B* is regenerated to the sodium form, the valves are turned and the hard water sent to bed *B* and the regenerating through bed *A*.

Ion Separation

In the case of the separation of ions, the operation depends on the basis of differences in the affinity of the resin for each of the two ions during their exchange between the solid-resin phase and the liquid-solution phase. Here again the separation method is a batch process. A typical operation is somewhat as follows: solution containing the mixture of ions to be separated is passed for a short time into the top of a column packed with a suitable ion-exchange resin. Then an eluting solution (for instance, hydrogen ion) is passed into the top of the bed to wash out the mixture of ions. This process gradually elutes the ions held on the resin, causing them to move down the column. However, the less strongly adsorbed ions move downward faster than the strongly held ions, so that if the time required to travel through the column is long enough, the ions will have traveled different distances and thus have separated, each forming a sharply defined band of pure ion in the column. Further flow of the eluant then sweeps each band of ion out of the column separately. To collect the separated ions, cuts of the out-

flowing solution are taken as each band exits. After all the ions have been removed from the bed, the column is placed back on the saturation or adsorption steps, and the cycle is repeated.

This has been shown in Figure 2, in which *A* indicates the saturating step and *B* the eluting step. Here, obviously, the calcium is the more strongly held.

Because of the necessity for regenerating the exchanger bed at frequent intervals, in both the removal and separation processes, ion exchange suffers from the disadvantages common to all batch processes. During the past two years, the Chemistry and Chemical Engineering department of Stanford Research Institute has sought to overcome some of these disadvantages by the development of continuous methods for ion removal and ion separation. Support for this program has come from the Institute itself, from industry, and from a government agency.

Lower Equipment, Resin Needs

Initially the problem consisted of developing equipment and techniques for continuous circulation and regeneration of ion-exchange resins. Several means of accomplishing this were developed, and they have been applied to specific problems. Some of the expected advantages of a continuous process, such as lower equipment and resin inventory requirements, have been realized in pre-pilot plant investigations. Potentially, continuous ion-exchange processes should replace large batch operations, but smaller throughputs will probably still be

more economically carried out by batch techniques.

As might be expected, the continuous method developed for ion removal utilizes a container of resin which is kept constantly in a highly regenerated state by removing a portion of the resin from the exhausted portion of the on-stream unit and transporting it to a washing and regenerating unit. Simultaneously, a corresponding volume of regenerated exchanger is returned to the deionizing portion of the cycle. This operation is shown schematically in Figure 3.

The continuous separation process is essentially a counter-current contacting of resin and solution with the feed mixture introduced at an intermediate point in the solution stream. The most strongly held ion will be taken up preferentially by the resin and moved in the direction of its flow,

whereas the least strongly held ion would tend to flow with the solution. Refinements to assist this separation would be top and bottom refluxes from contact devices analogous to the condenser and reboiler in a continuous distillation column shown in Figure 4.

In addition to the application of both continuous and fixed-bed ion exchange to specific problems, the Chemical Engineering Section also has under way a theoretical study of the phenomena occurring during both types of operation. This study should lead to a design theory which will form a sound basis for reducing these processes to standard chemical engineering practice. Progress has been sufficient at the present time to establish a partial basis for designing equipment for any particular process. This phase of study will continue to remain under active investigation.

Nourishing Unknown in Butter and Oleo

► BOTH butter and oleo may contain some as yet unidentified substance that is nourishing in addition to their fat, scientists at the U. S. Department of Agriculture report.

Special feeding tests with rats suggest its presence and work to track down the elusive factor is continuing. All rats used in the tests are treated alike except for the form in which they receive the fat which makes up either 10% or 30% of their diet. The fat is given as butter, butterfat, oleomargine or oleofat.

The diets presumably contain adequate amounts of all known nu-

trients, yet baby rats born from mothers raised on the special diets differ in their death rates and in their weights at weaning.

If the mothers were fed either the butterfat or oleofat diet only, their offspring were more apt to die or to weigh less at weaning than rats born of mothers who had always been fed on the butter and oleo diet.

This suggests that both butter and oleo contain some nutrient or nutritive property in their constituents aside from the true fats, the scientists state.

The study is included in the annual report of the Bureau of Dairy Industry.

Owned by the People of the United States.
Operated by the Atomic Energy Commission

The U. S. Atomic Energy Industry

Excerpts from remarks prepared by Commissioner T. K. Glennan of the United States Atomic Energy Commission for delivery at the fall general meeting of the American Institute of Electrical Engineers.

► URANIUM is about as plentiful in the earth's crust as lead. But a perverse nature has so widely distributed it that concentrated deposits are quite rare. For example, there are tons of the stuff in the Tennessee shales but the amount—in ratio to each ton of shale—is so small that recovery at present is not commercially feasible.

Fortunately, there are instances where it is possible to get uranium from very low-grade sources. It can be recovered as a by-product in the treatment of certain South African gold ores. Also, it is technically feasible to recover the uranium contained in phosphate rock as a by-product in the manufacture of fertilizer or other phosphatic products.

After mining, the next step is processing the ore. This is done in a number of private industrial plants about the country. To provide additional capacity, we are now building a 54-million-dollar processing plant at Fernald, Ohio, which the National Lead Company will operate for us. The end product of this processing activity emerges in two forms—natural uranium metal and uranium in a gaseous form known as UF_6 —uranium hexafluoride.

That brings us to the third step—the manufacture of fissionable materials. The uranium metal goes to Hanford, Washington, to be “cooked” in the giant reactors there, to produce plutonium. The uranium in gaseous form goes to Oak Ridge, Tennessee, where the more useful U-235 atoms are separated from the more numerous U-238 atoms in those great plants that house the gaseous diffusion process. [Another gaseous diffusion plant, costing a billion dollars, will be built in the Ohio River Valley, it was announced in April.]

Here, again, we are expanding our capacity. The half-billion-dollar investment being made at Paducah, Kentucky, and the new billion-dollar-plus Savannah River Plant under construction in South Carolina will produce fissionable materials.

The fourth step is the preparation for the manufacture of reactor fuel and weapon parts. At Hanford, the plutonium in its original state is in solution along with a lot of stuff—fission products, we call them—and has to be separated and converted into metal. Likewise, at Oak Ridge, the gaseous concentrated U-235 has to be made into metal.

The production line up to this point is the same whether you are desirous of building nuclear hearts of weapons or fashioning enriched fuel for reactors to produce power or to make radioactive isotopes. Today, as you

must know, the emphasis is on weapons. I can assure you that the major concern of the Commission is to make certain that our stock of weapons continues to grow at an accelerated rate. The designing of new and improved weapons is an important part of our military program and is integrated closely with the stated requirements of the military services. As in any developmental program, tests must be conducted and for this purpose we carry on operations at Eniwetok Atoll in the Pacific and at the Las Vegas test site in Nevada.

We have said that in Operation Greenhouse, the weapons exploded on the Eniwetok testing ground were several times more powerful than the bombs dropped on Hiroshima and Nagasaki.

We have said that we are now producing atomic weapons on an industrial basis. Beyond these statements we will not go now. One day the whole story can and will be told, but right now—let's look at some other facets of the atom business.

One part of the program which could itself be the subject of a long—and I would hope interesting—talk should be mentioned briefly. This is our production of radioisotopes for use in medicine, in industry, in agriculture, and in physical and biological research of hundreds of types. We make these substances principally at Oak Ridge and sell them at cost to qualified users. Since 1946 when the Manhattan Engineer District started distributing them, more than 19,000 shipments of isotopes have gone out from our plant. They are now used by more than 1,000 development and research departments of industrial con-

cerns and institutions located in 45 states, Hawaii and the District of Columbia and 16 foreign countries. The British and the Canadians too make and sell radioisotopes. They are a new tool for science around the world—a tool of greater power and use than any other tool developed for investigators since van Leeuwenhoek invented the microscope 300 years ago. They are more—some isotopes of certain of the elements are the means of diagnosis and healing in medicine and are the source of radiation used in many industrial process control operations.

While I am about it, I'd like to touch briefly on the importance placed by the Commission on research. Without new findings in basic science you cannot have new products and processes.

Our scientist colleague on the Commission, Dr. Henry D. Smyth, succinctly stated the urgency of basic research in an address before the Association for the Advancement of Science last December. He said then:

"In World War II, for the first time in history, we pushed our development of weapons close to the limits of our basic knowledge. Discoveries in science less than five years old were put to use in the atomic bomb and other weapons. This may happen again, but only if there is new knowledge to put to use."

The AEC is financing and stimulating the acquisition of new knowledge in its field. Some 40 million dollars annually is going into research in the physical and biological sciences.

There are other points I would like to make, but I will content myself with just two—the security and the

safety activities of the atomic energy program consume a large amount of effort and funds. We feel that the record of the AEC on both points is good; but we are not letting up on either front—in fact, we are continuously trying to improve security provisions and safety practices throughout the project.

Now, with the hope that thus far I have given you a condensed but useful picture of the Commission's operations, I'd like to turn to a discussion of the part played by engineers in this business with particular attention to the activities of the electrical engineer.

The Engineer and the Atom

Along with scientists, engineers are the key men of atomic energy development. Without engineers, we couldn't reach our objectives. The close working relationship, noted before in Dr. Smyth's quotation, between research and development in modern industry, has brought about a situation where about half our technical workers are engineers, and half are scientists. As for the governmental management of the enterprise, it is drawn in the main from the engineering profession.

Of the approximately 6,400 engineers in the program (excluding construction operations) last June 30, nearly one-fourth were electricals and radio engineers—approximately 1,500. Only mechanicals surpassed the electrical-radio group in number and they by a small margin. This is some indication of the importance of electrical engineering in atomic energy operations and development.

What do electricals do on the project? The answer was given in a brief

but informative paper by D. W. Cardwell of the Oak Ridge National Laboratory which was declassified and published about three years ago. He pointed out, to put it in broad terms, that electrical engineers supply power for the processes of the industry, they provide process control, and they furnish instrumentation of various sorts. Specifically he reported their part in high energy particle accelerator work; in radiation instrument development; in the design of equipment for and in the operation of the separation plants at Oak Ridge, and in reactor development both for production and for power and propulsion purposes.

You will notice that this group of functions cuts well across the whole spectrum of atomic energy operations and development. They involve some really difficult, pioneering problems, as well as unspectacular day-to-day operating functions. Take the field of the particle accelerator. This is still the fundamental tool of physical research in atomic energy. It comprises cyclotrons, betatrons, synchrotrons, cosmotrons, van de Graafs, etc., etc. They are so useful that there are now more than 70 of them in operation in this country, nearly all financed at least partially by the Atomic Energy Commission. The later designs have progressed to such size—130-foot diameter for the new one abuilding at the Radiation Laboratory, for example—that the electrical engineering problems are enormous; they are unprecedented. It is in this field that even the most experienced and ingenious engineers have to follow the formula, time and again, of testing their new designs by "throwing the switch, standing back and watching for smoke."

A characteristic phenomenon accompanying the release of atomic energy is radioactivity. Instruments for detecting and measuring radioactivity are required, in quantity, at numerous points in atomic energy processes. They are used to guard the health of the men and women working in plants and laboratories; in radioactive chemical assaying and in process monitoring. Most of the basic ideas for radiation detection devices have come from scientists, but the developmental work has become more and more exclusively the field of the electrical engineer. And here is an atomic energy field where private enterprise has moved in vigorously. The demand for better, more rugged, more sensitive devices mounts higher and higher. These market needs are being met in increasing volume by industrial concerns. It is a field by the way with direct relation to the common defense and security at many points, not least in the area of civil defense monitoring equipment.

In the development of reactors, the basic machines for making fissionable materials and isotopes, and the hope for production of electrical power from nuclear fuels, the electrical engineer is called upon again and again. Some of his toughest problems cluster around the development of the mechanisms that are needed to regulate accurately, the power level of operation. Physicists and electrical engineers have worked out a variety of complicated servo-mechanisms to bring this about.

They have combined their efforts to develop electronic devices and circuits that enable the reactor theoreticians, in their design studies, to simulate mathematical pile power relationships and represent the distributions

of neutron flux within the operational space of the reactor.

In the design and construction of the great uranium isotope separation plants at Oak Ridge, one of the two major sources of fissionable materials, the electrical engineers were called upon to perform semi-miracles. In the Manhattan District days, Oak Ridge employed the largest group of electrical engineers ever brought together for one general project. Some worked on the electromagnetic process, the first to produce uranium 235, though now abandoned in favor of the gaseous diffusion process.

These great diffusion plants at Oak Ridge, on which we now rely for separation of the fissionable U-235 atoms from the more plentiful U-238 atoms, are in being partly as a result of electrical engineering imagination. In fact, the electricals worked themselves and their fellow engineers out of a lot of jobs by successfully designing for K-25 and its sister plants automatic control systems that require very few operators. The plants are huge, but the operators required because of automatic controls are so few that they go about their job on bicycles.

Power From Atomic Energy

At this point it might be worthwhile taking a look at the relationships between the electrical power industry and the AEC and to discuss briefly the present stage of development of power-producing machines burning nuclear fuels. That the AEC system should be a very large user of current, adding to the burden on the electrical generating capacity of the nation, seems paradoxical and painful to those readers of the Sunday supplements who look to

nuclear fuels, burned in reactors, as a new and cheaper source of electrical power to lift the burden of man's drudgery. The atomic energy development program expects to vindicate the hopes of those who are confident of finding in uranium and thorium and reactors a new power supply. But it will be some time before atomic energy machines will produce as much power as the atomic energy industry consumes.

There isn't time available to me now to describe those projects of the AEC which have been undertaken for the purpose of exploring techniques which might be applicable in the power generation field. These projects include the reactors under design and development for propulsion of submarines and aircraft and experimental devices in the test phase or nearing completion at the reactor test station in Idaho. Numbered in the latter category are the experimental breeder reactor and the materials testing reactor, both of which will provide useful data for future developmental work.

The AEC continues to maintain, in spite of the pressure of its weapons program, a vigorous research and developmental program in this field. But we are not the only ones who have a stake in the development of such machines; obviously, if this should turn out to be an economical source of power, the power-making and power-using industries will be affected.

It is thus natural that industry should be interested in the development of power reactors. It has been difficult in the early years of the atomic energy industry to find ways and means, within the monopolistic character and the security requirements of

the AEC, of making this interest effective in speeding development. Now it appears that this may be brought about.

The Commission is very much pleased that four groups of firms have entered into agreements under which they are assigning—at their own expense—their best technical men and employing qualified consultants to study the reactor program. Eight major companies including Dow Chemical, Detroit Edison, Bechtel and Pacific Gas & Electric, Monsanto and Union Electric, and Commonwealth Edison and Public Service of Northern Illinois, are actively engaged in these studies.

The agreements provide for the making of analyses by the companies to (a) determine the engineering feasibility of their designing, constructing, and operating dual-purpose reactors to produce fissionable materials and power; (b) examine the economic and technical aspects of building such reactors in the next few years; (c) determine the possible research and development needed to validate their design thinking; and (d) recommend industry's role in designing, building, and operating such reactors.

Since only a limited number of studies are being undertaken and since they will be based on information acquired at public expense, yet not generally available to the public, AEC will determine the disposition of patent rights and use of reports to be made as a result of these studies.

When and if it is feasible to produce commercial power, many public policy decisions will be involved and the present atomic energy law may have to be changed. If you are familiar with

the McMahon Act, you will remember these words:

"Whenever in its opinion any industrial, commercial, or other non-military use of fissionable material or atomic energy has been sufficiently developed to be of practical value, the Commission shall prepare a report to the President stating all the facts with respect to such use; the Commission's estimate of the social, political, economic and international effects of such use and the Commission's recommendations for necessary or desirable supplemental legislation.

"The President shall then transmit this report to the Congress, together with his recommendations."

Thus, if the work being done by these four teams of industrial concerns should result in proposals for com-

mmercial power production and the formulation of a report as required by the Act, they will have rendered a real service not only to themselves, but to the people and industry generally. They will have brought into focus the economic problems of power production from nuclear fuels.

For myself, I am greatly heartened that these concerns are investing their own funds in such pioneering effort. Their action is an example of what free enterprise really means; and thank goodness it still persists and thrives, even in the face of the peculiar conditions and difficulties surrounding atomic energy development in an embattled world. Success in applying the push of private investment and initiative in this field will broaden the opportunities and increase the complexities of the electrical engineer's job.

Fluorocarbons Commercial Product

► UNRULY fluorine, now tamed in a relatively new family of chemicals known as fluorocarbons, has found so many industrial uses that these carbon compounds have now entered production on a semi-commercial scale.

The plant was constructed at Hastings, Minn., and is being operated by Minnesota Mining and Manufacturing Company of St. Paul. An electrochemical process is used. It is based on inventions by Prof. J. H. Simons of the University of Florida.

Primary use for the fluorochemicals is in manufacturing other products such as resins, dyes, pharmaceuticals, polymers, solvents, refrigerants, fire-extinguishing compounds, dielectrics, hydraulic fluids and lubricants. Made

with the aid of fluorocarbons, they have such improved qualities as greater heat and chemical stability, unusual optical properties, greater surface activity, increased fire resistance and more resistance to fungus.

Their resistance to heat, corrosion and acid formation gives them possible applications in permanent lubricants and hydraulic fluids, replacing oil. Certain fluorochemicals will produce what is known as wetter water, that is, water which has greater ability to penetrate clothing in the wash tub or other surfaces on which it is applied.

In the Simons process no free fluorine is used. A'l danger of handling this chemical is eliminated.

News From the A. C. S. Meetings

➤ AN END TO danger from sweaters bursting into flame is promised in a report by Prof. James M. Church of Columbia University, New York. New organic chemicals which contain phosphorus make fibers fireproof but avoid the trouble of losing the fireproofing material in the wash. Sweater and other rough textured materials treated with the new fireproofing chemicals can now be worn and washed with assurance that, if a cigarette ash should set fire to the garment, the heat will transform the fireproofing compound clinging to the fibers into phosphoric acid which will efficiently smother both flames and afterglow.

Life Molecules Seen

➤ SCIENCE has seen for the first time the giant chemical molecules that seem to play an important role in heredity and the changing of one disease into another.

Drs. John W. Rowen, Maury Eden and Herbert Kahler of the National Cancer Institute, Bethesda, Md., announced to the American Chemical Society in Milwaukee that by the use of the electron microscope they had seen for the first time a single nucleic acid molecule.

This kind of macromolecule is found in large quantities in the hearts of living matter, particularly in the chromosomes and genes of all cells that carry on the biological stream of life.

These nucleic acid molecules are

also the major constituents of viruses. The desoxyribose nucleic acid extracted from such bacteria as the pneumococci, staphylococci and coon bacillus has the extraordinary property of transforming one type of bacteria into another type. This transformation, known as mutation, takes place only when the nucleic acid molecule is present as a giant molecule.

The single molecule was found to be approximately on ten-millionth of an inch in diameter and approximately three 100-thousandths of an inch long.

New Fuel Hydrocarbons

➤ NEW SOURCES of aviation fuel spur chemists to create hot-burning liquids economical to manufacture. R. M. Caves and R. L. McLaughlin of the Mellon Institute, Pittsburgh, and P. H. Wise of the National Advisory Committee for Aeronautics, Cleveland, reported to the meeting of the American Chemical Society in Buffalo on their success in making a series of such compounds.

Linking together substances similar to carbolic acid and hydrocarbons derived from propane, these chemists get a satisfactory amount of new hydrocarbon compounds in a series of three diphenyl alkylpropanes and the corresponding dicyclohexyl compounds.

Thirteen new organic compounds never before reported were described at the same meeting by George F. Lewenz of the Lewis Flight Propul-

sion Laboratory, National Advisory Committee for Aeronautics, Cleveland, and Kasper T. Serijan, Armour and Co., Chicago. An additional 22 new compounds of another series were prepared by this team, in a program to provide samples of known structure with which to compare chemicals to be identified in the future. The chemists described their methods of making these new additions to the aromatic series of organic compounds.

Antibiotics Help Chickens

► ANTIBIOTICS such as penicillin are more efficient in promoting the growth of chicks than are either germicides or detergents having the same kind of effect in the chick's body.

This is found by Dr. Joel R. Stern, Joyce C. Gutierrez and Dr. James McGinnis of the State College of Washington. The scientists are investigating the belief that stimulation of growth by penicillin is the result of mechanical action in killing off harmful bacteria in the chicken's intestinal tract. Dr. Stern and his group reported that the effect of the antibiotic is greater than that produced by much larger quantities of chemicals not of antibiotic origin.

Plutonium in Bone

► PLUTONIUM, man-made atomic bomb element, builds itself into the bones when it is absorbed by the body, but does not replace the calcium of which the bone is made. The addition to knowledge about the action of this poisonous and radioactive element was reported by Walter E. Kisielewski and Austin M. Brues of Argonne National Laboratory, Chicago. Fifty-five per cent of the plutonium injected is still retained by the body 265 days later, mostly in bone.

Origin of Solar System

► RECORDS of the formation of our Solar system have not been destroyed, Dr. Harrison Brown of the California Institute of Technology told the Buffalo meeting of the American Chemical Society, when he received the Society's award in pure chemistry.

Explaining his chemical theories of the origin of our solar system, he said we have only to learn to read these records correctly. The chemist, the geologist, the astronomer and the physicist, working together, can successfully reconstruct the process.

Two groups of planets which differ dramatically in their weights and densities move around the sun. The atmospheres of these planets also differ. Carbon dioxide in the atmospheres of Venus, earth and Mars tells astronomers and chemists that carbon is highly oxidized on these inner planets.

In contrast, the sun's giant outer planets, Jupiter, Saturn, Uranus and Neptune, have methane in their atmospheres, and at least on Jupiter there is an appreciable quantity of ammonia. This means that carbon exists there in a highly reduced state. Opposite kinds of elements are believed to make up the bulk of these two kinds of planets, the heavier metals compose earth and the other dense, solid inner planets. Outer planets are so light that they must be made largely of gases with hydrogen and helium predominating.

What conditions, Dr. Brown asked in his address, would the chemist recognize as necessary to form such a series of planets, supposing our universe to start with the average composition of cosmic matter?

Three groups of elements and compounds could exist, according to Dr. Brown. Those easily condensable would contain metals, oxides and silicates, a small fraction of the whole. Such materials make up the inner planets. Elements and compounds of intermediate condensability include water, ammonia and methane. Jupiter must have been in the best position to take up the bulk of such material.

Left over are hydrogen and helium which would not condense at the temperature of space. These light elements were not so much lost from planetary atmospheres as not captured at the time of formation.

Air and water must, according to this theory, be of secondary origin, formed by reactions among the elements present after the formation of the planets similar to earth. These include not only the inner group but also Pluto, the farthest of the planets. Interpretation of the possible chemical reactions would allow scientists to read the conditions which must have been present to account for the chemical facts now evident in the solar system.

Warn of Smog Poisons

► DANGERS due to ordinary poisonous chemicals can now be detected by monitoring devices worn by workers exposed to them, just as atomic workers carry small instruments to detect radioactivity.

A new safety device for this purpose was described by Gordon D. Patterson, Jr., of Du Pont and Dr. Melvin G. Mellon of Purdue University, reporting their work on air pollution to the Buffalo meeting of the American Chemical Society.

Sulfur is the element blamed for smog and similar industrial fume problems. The new indicator described by these chemists turns yellow, green or blue according to the amount of sulfur compounds in the air. The colors appear in vanadate-silica gel which is packed into a glass tube. One of these tubes can be worn by each worker. Other tubes can be used to analyze stack gases.

An alternative detecting material, periodate-silica gel, also used in the new indicator tubes, changes from white to pink and then to red brown when there is sulfur dioxide in the air.

Artificial Harbor Tests Tides

► CIVIL DEFENSE experts will know how much time it will take to make our harbors safe after an under-water A-bomb explosion as a result of a "theoretical flume" in operation at Woods Hole Oceanographic Institution in Massachusetts.

The flume is an oblong glass channel. Fresh water comes in at a steady rate at one end and salt water, regulated to simulate the tides, comes in

and goes out at the other end. When dye is added to the salt water, it can be seen moving up the stream as a sort of wedge.

With this model of a theoretical harbor, scientists can study how long it will take for radioactive water and debris to be flushed out to sea. The same knowledge can be applied to biological warfare agents used to contaminate one of our harbors.

Antibiotics Fed to Chickens Stop Growth of Germs in Eggs

Miracle Drugs in Food

➤ ALL OF US are probably eating some of the modern miracle drugs every day with our breakfast eggs and our fried chicken or roast pork for dinner. So far as anyone knows, however, we will not eat enough antibiotics this way to have them do us any good or harm.

The reason we are eating minute amounts now is that mashers containing some of the antibiotic drugs, such as aureomycin and terramycin, are being fed to young chicks and pigs to speed their growth.

Discovery that eggs from commercial hatcheries where antibiotic mashers are fed to chickens contain some of the antibiotics was made by Drs. Donald Greiff and Henry Pinkerton of St. Louis University, St. Louis, Mo.

They found this out in the course of experiments with the germs of typhus fever. These germs, called rickettsiae, were being grown on the yolk sacs of fertile eggs. When the hatcheries where the eggs came from started using antibiotic feeds, the rickettsiae failed to grow on the eggs. The antibiotics stopped the germs, just as they do when used to treat people sick with typhus fever and many other germ-caused diseases.

Antibiotics can get into milk, also. Cheese manufacturers earlier had discovered that the starter organisms for making cheese failed to grow in some lots of milk. This milk, they found, had come from cows that had gotten "shots" of antibiotics to cure them of mastitis.

These cows had gotten the antibiotics injected into their udders, where the mastitis-causing germs were. Feeding antibiotics to lactating dairy cows, however, does not result in any of the antibiotic getting into the milk, according to experiments just reported in the journal, *Science*. These experiments were made by M. O. Haq, L. L. Rusoff and A. J. Gelpi, Jr., of the Louisiana Experiment Station at Baton Rouge.

Eggs are used for growing influenza germs to make anti-flu vaccines. Influenza A virus will grow on the eggs from antibiotic-fed chicks, the St. Louis University scientists found. But they point out that other disease-fighting experiments in which eggs are used to grow the germs for research purposes may be affected.

Eating eggs, chickens and hogs that have antibiotics in them will not do any harm, in the opinion of the Food and Drug Administration here. FDA officials point out that the amount in the egg or meat is so small it could not have any effect on humans eating it. Furthermore, ordinary cooking would destroy the antibiotics.

One possible adverse effect of feeding antibiotics to animals to speed their growth has been pointed out in a report by Drs. M. P. Starr and D. M. Reynolds of the California Experiment Station at Davis, Calif., to the *American Journal of Public Health*. These scientists warn that the spread of drug-fast strains of germs to larger

animals could be serious since the value of the meat of these animals

would justify treating them with antibiotics when they get sick.

Color Helps Sort Fruits and Vegetables

► **BETTER QUALITY** fruits and vegetables are foreseen through the use of colored lights in sorting defective food from good material.

G. M. Peterson and W. M. Carleton of Michigan State College's Agricultural Experiment Station at East Lansing find that the problem of spotting small defects is much simpler when background and lighting colors are carefully chosen.

Besides changing the lighting color, they suggest that inspection belts be

given the right color either by making the rubber the required shade or by using a transparent belt with the right color placed underneath. Rubber conveyor belts can not be painted for sanitary reasons.

This new approach to detecting small but important defects in fruits and vegetables increased the efficiency of workers as much as 64%, recently completed tests with cherries in 13 Michigan processing plants showed.

Hormone Spray Keeps Lemons Fresh

► **FOR** lemonade drinkers or lemon pie addicts: The life of lemons after they reach the packing house has been increased up to 50% in the last two years by use of hormone sprays in the packing process.

Developed by scientists at the University of California's Citrus Experiment Station, Riverside, Calif., methods of treating with 2,4-R, or the closely related and more active hormone spray, 2,4,5-T, are now fairly generally used for reducing loss of lemons in storage.

The effect, explains Dr. Louis C. Erickson, is to keep the stem end, or button, of the lemon alive and green and prevent internal changes which accompany aging of the fruit. Preserved in their original condition, the lemons are less susceptible to certain

rotting fungi.

Without treatment, when lemons are held in the storage houses for extended periods, the buttons die and turn back. After they do so, fungi may and frequently do penetrate the fruit.

Lemons are picked before they attain the familiar yellow color. Tree-ripe lemons do not keep nearly as well as those just turning color, full-sized but still quite green in color. Usually the storage life of green lemons is about four months. With hormone treatment, Dr. Erickson reports, it is easily possible to keep them six months.

Lemons harvested in the spring can thus be kept until the demand is great in the hot months of summer and early fall.

Many Standard Materials
Now Chemical Products

Chemicals from Petroleum

Reprinted from "For Instance," American Cyanamid Co.

► ONLY a few years ago you could be sure that material for textiles originated on the farm, glycerin was obtained from fats, and alcohol from grain or molasses. Today, these and many other chemicals may be obtained from petroleum. To accomplish this remarkable feat a new era in chemical processing was inaugurated.

Petroleum oils are hydrocarbons, which means that their molecules are composed of various arrangements of carbon and hydrogen atoms. Gasoline and naphtha have small molecules with from 4 to 8 carbons and about twice as many hydrogens. Heavy oils have about 15 carbons and paraffin wax as many as 25 carbons with the necessary hydrogens. Alcohol and glycerin molecules contain oxygen in addition to carbon and hydrogen, but if you mixed oxygen with petroleum till doomsday you would not obtain alcohol or glycerin. However, if you "crack" petroleum at high temperature and pressure you will obtain a series of small hydrocarbon molecules. One of the most important of these is ethylene, for which the chemist writes: $\text{CH}_2=\text{CH}_2$. Ethylene can be activated readily and is then written: $-\text{CH}_2-\text{CH}_2-$. Now it has two arms to which an atom of oxygen or a molecule of water, H_2O , may be added. The H_2O addition produces the desired alcohol: $\text{CH}_3\text{CH}_2\text{OH}$,

and addition of oxygen gives the important chemical, ethylene oxide: CH_2-CH_2 . What happens when



H_2O is added to ethylene oxide? The result is ethylene glycol: $\text{HOCH}_2-\text{CH}_2\text{OH}$, which is widely used as a permanent antifreeze and in many other products. And this is simply the beginning of a long list of important chemicals which are made from ethylene and ethylene oxide.

Since glycerin, $\text{CH}_2\text{OHCHOH}-\text{CH}_2\text{OH}$, has three carbons in its molecule it seemed advisable to start with another hydrocarbon called propylene: $\text{CH}_3\text{CH}=\text{CH}_2$. But, as you can see, simple addition of H_2O would give an excess of hydrogens for the required three oxygens, so a several-step process was required. It was successful commercially and has brought some relief to the critical shortage of glycerin.

Other chemists visualized great possibilities from a little molecule called acrylonitrile: $\text{CH}_2=\text{CH}-\text{CN}$. They now make millions of pounds of it each year by adding hydrocyanic acid, HCN , to ethylene oxide, then removing a molecule of H_2O . You may do it easily on paper, but it is quite another matter to produce it commercially with uniformly high purity and in good yield. You can see

its potential reactivity; simply open up the double bond and you can attach many things to it. It is a basic chemical for drugs and dyes, synthetic rubber and plastics, and textiles which have the gossamer loveliness of silk, the kinky character of wool and greater strength and durability than natural textiles.

Penicillin Saves Lockjaw Victims

► **PENICILLIN** can help save lives threatened by tetanus, or lockjaw, the deadly infection which can get into war wounds as well as those made by stepping on a nail in the garden.

The famous mold remedy can wipe out the tetanus infection in most cases within 24 hours after injections of it have been started, four Puerto Rican scientists report in the *Journal of the American Medical Association*. The four are Drs. R. S. Diaz-Rivera, Emilio Ramirez, Eduardo R. Pons,

In 1925 less than 0.1% of our organic chemicals was produced from petroleum, in 1946 this had risen to 28%, and the percentage is increasing each year. Almost 7,000 new chemicals have been made available commercially over this 25-year period and an increasing number are from petroleum.

Jr., and Mercedes V. Torregrosa, all of San Juan.

Antitoxin is needed to neutralize the toxin, or poison, produced by the tetanus germs, they point out. But penicillin helps save patients by stopping the growth of more germs, and thus preventing more toxin getting into the patient's body.

In the cases they reported they used both tetanus antitoxin and penicillin, in addition to surgical cleaning of the wound and sedatives to stop the convulsions and spasms.

Jet Engine Cost Cut by New Process

► **MORE THAN** half of the 2,000 tiny compressor blades that are the "heart" of the jet airplane engine in the Boeing B-47 can now be made by a new, much cheaper process, the General Electric Company reported from Lynn, Mass.

Previously all of the blades and the bases in which they are fixed have had to be hammered from a single piece of stainless steel. Each of the blades resembles an airplane wing, and its air foil shape must be exact. Using the new process, the blades are rolled in long strips, contoured to the proper

air foil shape, and cut to the desired length during assembly.

The tiny blades are used in the compressor, the device which forces air in great quantities to the combustion chambers of jet engines. It consists of a rotor and a stator, both of which have hundreds of blades. As the rotor turns, air is forced through the rotor and stator blades and compressed as it travels to the rear toward the combustion chambers. The fabricated blades can be used only for the stationary blades. The rotary blades will continue to be forged because of the high centrifugal stresses involved.

With Systemic Insecticides Plants Kill Own Enemies

Inside Dope

Reprinted from the INDUSTRIAL BULLETIN of A. D. Little.

► NEXT year will see the first U. S. commercial production of insecticides designed to meet agriculture's long-standing desire for a selective killer. These "systemic" insecticides are taken up in the sap stream of the plant, rendering it toxic to injurious chewing and sucking insects, but harmless on contact with others which may be beneficial. Although the principles and advantages of systemic activity are not new, previous attempts to develop a satisfactory product were unsuccessful. Now, two of the new series of organic-phosphates, originating in the Bayer laboratories in Germany, are under intensive investigation in this country. The first, scheduled for production here pending Department of Agriculture approval, is currently available in experimental quantities. Known to chemists as octamethyl pyrophosphoramidate, it is called OMPA and schradan, and in formulation as Pestox. One U. S. company may produce as much as 100,000 pounds next year. The second material, known in formulations as Systox, has had extensive field testing this year.

Although the price level anticipated for OMPA — \$6 to \$7 a pound — is higher than for conventional insecticides, it gives excellent results in concentrations below 0.2 per cent, and requires less frequent application. Prices for Systox are as yet unknown, but the expected application level may be as low as a quarter of a pound to

the acre. Both materials can be applied by spraying on the foliage or through the roots via irrigation water or ground soaking. Because the insecticide moves from the roots and stems to the leaves more efficiently than from leaf to leaf, more material is needed for leaf spraying, and the second method is considerably cheaper and more effective where it is practiced. When leaf spraying is done, however, the plant will tend to distribute the poison from areas of high concentration to other parts.

Eventually chemical action within the plant renders the poison ineffective with the period of toxicity varying with the insecticide and the stage of plant growth at the time of application. On young actively growing plants, the effective period for OMPA may be four to six weeks; on older plants, it may last somewhat longer. Systox, on the other hand, dissipates faster initially, but levels off at a low concentration and retains an insect-killing efficiency for a considerable length of time.

Since the organic-phosphorus products are toxic to warm-blooded animals, residues above the level to be set up by the Department of Agriculture may constitute a hazard for food and fodder crops. Department of Agriculture statements, in general, prescribe at least a six-week period between the last spraying and harvesting, and current use is restricted to

ornamental plants, such as roses and chrysanthemums, and to extensive experimental activity with commercial crops. Another product in this group is Isopestox, which shows promise as a last-minute measure to quell an infestation near harvest time, since it soon becomes harmless.

In spite of a host of new insecticides during the past several years, the annual loss to insects has climbed to about \$4 billion annually and may go still higher. This paradox is partly due to the recent mild winters which allow pests to live to another spring, but is also attributable to serious drawbacks in conventional insecticides, which often permit the pest population to bounce back to new highs after each treatment. One difficulty is that the modern powerful products kill not only harmful insects but also other insects which prey upon them. When a large proportion of both pest and beneficial insects is killed, the remaining beneficials may migrate to seek another source of food, leaving the field clear for the surviving pests and their immigrating relatives to multiply more rapidly than ever. Another drawback has been the build-up in recent years of insect strains which are resistant to the insecticide used. Answers to the problem have been more frequent spraying or rotation of insecticides to kill off resistant strains.

Many experts believe that attempts to achieve 100 per cent destruction are hopeless and prohibitively expensive, but that by seeking to restore the "balance of nature" through biological as well as improved chemical control, losses to insects can be kept

to a reasonable level at a reasonable cost. In areas where methods of agriculture have not interfered with the normal predator-prey relationship, the problem of insect pests is less serious, but when large areas are devoted to a single crop, the rich food supply calls forth an unusually large pest population, and deliberate steps must often be taken to hasten the appearance of natural enemies to help combat the pests. By using selective insecticides, such as the systemics, and applying them relatively infrequently, the pest population is kept down, and control may be aided by beneficial insects, if the pest population is high enough to sustain them.

Systox and OMPA appear to be highly successful in this respect. OMPA, for instance, kills a high percentage of aphids, but has little effect on ladybugs which feed on aphids. In large-scale experiments with cabbage aphids, one application of OMPA kept the crop free all summer; more sweeping extermination by another insecticide was followed by rapid reinfestation necessitating another spraying. Recent extensive experiments with Systox show excellent control of sucking insects. Neither OMPA nor Systox appears to have any effect on bees or birds in the treated areas.

The immediate market for the organic-phosphorus systemic insecticides is expected to be limited to non-food crops, such as ornamentals and possibly cotton-insect control. As more information is obtained on desirable concentrations and handling techniques for other crops, this new class of insecticides may be expected to find wide application.

Inventions in Chemical Fields

Twenty-five cents in coin, money order or Patent Office Coupons (do not send stamps) will bring a copy of a patent if ordered by number from the Commissioner of Patents, Washington 25, D. C.

Flame-Cutting

► A FLAME method of cutting metals which, unlike certain others, can be used for cutting both ferrous and non-ferrous metals, brought patent 2,582,946 to Warren E. Brill, Haddon Heights, N. J. It is usable for cutting high carbon steel.

The torch used is similar to the well-known oxy-acetylene type but provides flame discharge at two different pressures.

In the first step in cutting, oxygen and acetylene are used in the proportions required to produce a neutral flame. After this flame is used long enough to make a small puddle of molten metal at the point of cutting, oxygen under high pressure is released into the flame which blows the molten metal away without burning it or scoring the surrounding metal.

Heating Chamber

► HEATING CHAMBER through which objects to be subjected to rapid heating by ultrahigh-frequency radio waves are passed on a moving platform on rollers employs a type of roller which does not change the standing wave distribution or permit loss of energy from the chamber.

The heating chamber like others, is made of an electrical conductive

material and power is supplied to it from a high frequency source. The rollers near the base of the chamber are made of low-loss dielectric material with their ends passing through apertures in the side walls of the chamber. They then pass through cylindrical sleeves which surround the ends of the rollers. These are made of the same material as the sidewalls of the chamber itself.

Inventors are Philip W. Morse, Elnora, and Maurice F. Davis, Syracuse, N. Y. Their award was patent 2,583,338. Rights have been assigned to General Electric Company, Schenectady, N. Y.

Silica Gel Grease

► A NEW KIND of waterproof lubricating grease, for use on ships and wherever moisture might decrease the efficiency of ordinary grease, has been invented.

Two Canadian inventors, Aurelio F. Sirianni and Ira E. Puddington, of Ottawa, have assigned their five patents on the new kind of grease to the Canadian Honorary Advisory Council for Scientific and Industrial Research. They received American patents number 2,583,603 through number 2,583,607.

Most lubricating greases made with a silica gel, the inventors say, have an affinity to water. Any water which comes in contact with the lubricating grease tends to replace the oil content in the grease. The inventors have stopped this process by waterproofing

the silica gel with certain alkyd resin components.

The two inventors have also improved the process of making lubricating grease from an aqueous gel by finding a way in some cases to cut out some of the various steps previously necessary in replacing the original water in the gel with the oil used in the grease.

Crude Oil Defoamer

► MINUTE bubbles of hydrocarbon gas which pass into oil wells from the surrounding sands under certain conditions, may decrease or even wipe out the efficiency of the oil well pump. Two inventors, who have assigned their invention to the Socony-Vacuum Oil Company, Inc., New York, have discovered a method of defoaming the crude oil while it is still in the well. Euclid V. Watts, South Pasadena, and Bert Folda, Jr., Los Angeles, Calif., received patent number 2,585,522 for discovering that introducing minute amounts of dihydrocarbon silicates and silicones into the well would effectively get rid of the bubbles.

Insect Bait

► COMBINING dry insecticides with wheat dust instead of the usual insecticide carriers may prove a better way to protect stored wheat against insect infestation, according to patent number 2,585,356 issued to George B. Wagner, Minneapolis, and assigned to Pillsbury Mills.

Fire Protection System

► DANGEROUS fumes from a fire sometimes kill more people than the fire itself. This is the basis for the invention of a new method to draw off the fumes, thus preventing them from spreading from the source of the fire through all parts of large buildings.

The inventors, James Dunlop, Camp Gaw, N. J., and Edwin F. Durang, West Orange, N. J. received patent 2,586,797 for their invention. Half rights have been assigned to the Westinghouse Electric Corporation, East Pittsburgh, Pa., and the other half to the Otis Elevator Company, New York.

The invention consists of a series of ducts, placed so they will catch fumes traveling through openings, such as doorways, stairwells, or elevator shafts. Exhaust fans eject the fumes into the open air. A curtain of water, from sprinklers, is also used to impede the flow of the fumes.

New Germanium Alloys

► NEW GERMANIUM alloys which combine the germanium with gases such as nitrogen, as well as other elements such as copper, silver, magnesium, titanium or uranium, and rectifiers made from those alloys have received a patent.

Inventors were Dr. Karl Lark-Horovitz, head of the department of physics at Purdue University, La Fayette, Ind., and Dr. Randall M. Whaley, professor of physics at the same institution.

Dr. Lark-Horovitz, Seymour Benzer, Pasadena, Calif., and Robert E. Davis, East McKeesport, Pa., also received a patent for a photoresponsive and thermoresponsive cell utilizing germanium bombarded with neutrons so as to have alternating strips of negative and positive type conductivity. The two patents were numbered, respectively 2,588,253 and 2,588,254.

The germanium alloys patented by Dr. Lark-Horovitz and Dr. Whaley may be used as semi-conductors for

rectifiers of the contact type which among other things can stand high, continuous operating voltages, have low forward resistances and high back resistances, do not require power for heating a cathode and do not require more space than about that needed for a common one-half watt carbon resistor.

The alloys patented are all of the class of negative-type semi-conductors.

The second patent provides for a method of producing the alternating negative and positive strips by shielding alternate strips with a material which protect them from bombardment.

Both patents were assigned to the Purdue Research Foundation.

Garand Receives Patent

➤ JOHN C. GARAND, Springfield, Mass., inventor of the famous Garand rifle carried by millions of Americans in World War II and in Korea, has received patent number 2,587,611 for improvements in a valve mechanism on the rifle to be operated when a grenade launcher assembly is attached to the rifle. He assigned his patent to the government.

In launching a grenade with a rifle, he explained, the gases in the barrel build up a great deal of pressure. The purpose of the valve is to relieve that pressure and thus save the recoil mechanism of the rifle from excess wear. The valve is opened by force when the grenade launcher is attached to the rifle, but it cannot be jarred open when the launcher is not in use. The valve also closes readily after the launcher is removed.

Atomic Pile Simulator

➤ SOME OF the response characteristics

of an atomic pile have been electrically simulated in invention patent number 2,587,919. The inventors are Henry A. Strauss, Baltimore, and Persa R. Bell, Jr., and Forrest H. Murray, Oak Ridge, Tenn. They assigned their patent to the Atomic Energy Commission.

The most difficult and critical problem in operating a neutron reactor, or pile, the inventors said, is that of controlling the power level or neutron density so it does not grow to dangerous proportions.

In order to do this, the inventors have made an electrical device which has the same time-dependent response characteristics as a reactor. The voltage in the device varies with time in exactly the same manner as does the neutron density of a reactor. The device, the inventors claim, can be used for establishing procedures for start-up, shut-down and operation of a reactor, for training, for design and testing of servo systems, for studies of response of the reactor to unusual disturbance and for obtaining information as to power levels which would be attained should the reactor get out of control of the normal control equipment and be shut down by the emergency controls.

Flame Cultivator

➤ AN ATTACHMENT to a farm tractor which burns weeds but does not hurt the growing crops has been patented by Ames K. McNeill, Gary, Ind., and assigned to the International Harvester Company. He received patent number 2,587,873 for his invention.

The flame moves across the crop row, attacking the weeds and doing no substantial harm to the growing crops. It is more readily adaptable to

the cultivation of plants which develop a large stem and a root system which firmly holds the plant in the soil, the inventor said.

Weather Instrument

➤ A METEOROLOGICAL indicator for predicting local weather conditions won patent number 2,587,946 for Louvan E. Wood, Baltimore. He assigned his patent to the Bendix Aviation Corp. The device combines barometric pressure readings with specific humidity measurements.

Water-Repellent Fabrics

➤ TWO NEW, related methods of waterproofing both natural and artificial fabrics so they stand up to laundering better and are easier to handle have just received patents from the government.

The inventor is Firth L. Dennett, Midland, Mich., who assigned his patents, numbers 2,588,365 and 2,588,366, to the Dow Corning Corp., Midland.

According to one patent, the material to be made water-repellent is wetted with a mixture of two organosiloxane polymers and then heated at temperatures of from 100 to 475 degrees Fahrenheit for a short period of time. This treatment, the inventor says, will render the material substantially water-repellent even after laundering or dry cleaning. It also eliminates or materially reduces "mark-offs," lines which appear where materials made water-repellent by other methods have been folded or creased.

The second method uses a mixture of three organosiloxane polymers, but the same treatment. Other methods

using siloxanes, the inventor says, made smooth-fibered fabrics, such as rayon and nylon, too slippery. This affects handling and cutting. His method, the inventor claims, eliminates this problem.

Oil From Shale

➤ MORE OF the oil can be extracted from oil shale by a new method which has received patent number 2,589,109. The inventors, Homer Z. Martin, Roselle, and Frank T. Barr, Summit, N. J., assigned their patent to the Standard Oil Development Company.

Other methods of extracting the oil consist of "fluidizing" the oil shale—changing it into a fine powder to give the shale some of the characteristics of a fluid. The fluidized shale is then distilled, the heat necessary to distillation being supplied by burning portions of the combustibles in the distillation zone. Some of the oil is lost through burning by this method.

In the new method, the inventors claim, this loss of oil is avoided. Heat is supplied by adding another fuel, such as coal. The coal may either be used in a separate heater or added to the powdered shale. If the added coal fragments are of a larger size than the shale fragments, they will burn, while the shale and some of its oil will not burn.

Table Dessicator for Salt

➤ SALT keeps flowing from a new salt shaker no matter how damp and humid the weather may be. James H. Young, Mount Lebanon, Pa., received patent number 2,588,600 for the salt shaker. A dessiccant is held within the salt shaker between the cap and the part where the salt is.

Condensations

- *How to Solve General Chemistry Problems*—C. H. Sorum (*Prentice-Hall*, 157 p., paper, \$1.85.) It has been the author's experience that students succeed better in learning how to work problems when they have them, together with explanations, in a separate book.
- *Modern Gardening: A Complete Guide to the Agricultural Uses of Modern Chemistry's Miracle Drugs*—P. P. Pirone (*Simon and Schuster*, 371 p., \$3.50.) Practical information and advice for the home gardener. The second part contains answers to 500 questions.
- *Problems in Physical Chemistry*—Lars Gunnar Sillen, Paul W. Lange and Carl O. Gabrielson (*Prentice-Hall*, 370 p., \$7.35.) To aid the student in becoming familiar with thermodynamic quantities by learning the relations between them and why they change with varying conditions.
- *Progress in Organic Chemistry: Volume I*—J. W. Cook, Ed. (*Academic Press*, 287 p., illus., \$7.80.) Concise descriptions of recent developments in selected fields of the science. The eight chapters are contributed by nine authors.
- *Some Applications of Atomic Energy in Plant Science*—Atomic Energy Commission (*Govt. Printing Office*, 211 p., illus., paper, 50 cents.) Reports indicating the harmful effects of radiation on plant growth, and also accounts of research with isotopes on plant physiology. This is the same as the eleventh semi-annual report of the U. S. Atomic Energy Commission.
- *The Theory of Isotope Separation as Applied to the Large-Scale Production of U235*—Karl Cohen (*McGraw-Hill*, 165 p., \$2.00.) Reports issued by the theoretical division of the SAM laboratories and its antecedents covering work done from 1940 to 1945 plus new material from outside sources.
- *Elements of Thermodynamics and Statistical Mechanics*—E. O. Hercus (*Melbourne University Press* [*Cambridge University Press*], 153 p., illus., \$3.75.) A concise text for physics majors.
- *Food and Nutrition*—E. W. H. Cruickshank (*Williams & Wilkins*, 2d ed., 443 p., illus., \$6.50.) Revised and brought up to date in this second edition.
- *Prospecting for Uranium*—U. S. Atomic Energy Commission and the U. S. Geological Survey (*Govt. Printing Office*, rev. ed., 128 p., illus., paper, 45 cents.) In case you plan to spend your summer vacation seeking your fortune by hunting uranium, here are valuable suggestions and data.
- *Protection and Electrodeposition of Metals*—Department of Scientific and Industrial Research (*HMSO*, 350 p., illus., \$6.75.) Reports of research carried on during the war by the Ministry of Supply and the Ministry of Aircraft Production and now made public for the first time.
- *Science and Humanism: Physics in Our Time*—Erwin Schrodinger (*Cambridge University Press*, 67 p., \$1.75.) This outstanding physicist examines the question, "What is the value of scientific research?"

Proudly Presented

- ANALYTICAL reagents are being packaged in bulk quantities by Mallinckrodt Chemical Works, St. Louis 7, Mo.
- BAKELITE and Vinylite plastics are described as to specific properties, industrial applications and ability to be molded, extruded, calendered or otherwise formed in manufacture in a booklet offered by the Bakelite Co., a division of Union Carbide and Carbon Corp., 122 E. 42nd St., New York 17, N. Y.
- "DUST and Mist Collection" is the title of Chapter 9 of the Air Pollution Abatement Manual which is being published chapter by chapter by the Manufacturing Chemists' Association. Lists of other chapters of this work and other publications of the association will be sent on request to them at 246 Woodward Bldg., Washington 5, D. C.
- SAFE USE of acetic acid is explained in Safety Data Sheet SD-41 published by the Manufacturing Chemists' Association, 246 Woodward Building, Washington 5, D. C., at 35 cents per copy. Safety data sheets on other chemicals are available from the association at similar low prices. Remittance should accompany order.
- THE UNIQUE collection of pharmaceutical ancientware assembled by Dr. W. Wilson McNeary, trustee and recording secretary of the Philadelphia College of Pharmacy and Science, has been presented by him to the college, and is on display in the second floor foyer at 43rd St., Kingsessing and Woodland Aves., Philadelphia 4, Pa.
- CHLOROMYCETIN and other products made from hexamethylenetetramine are featured in the midwinter issue of the Dupont Magazine, Wilmington, Del.
- METHYLCYCLOHEXYL stearate is offered as a plasticizer for chlorinated rubber as well as for crude and vulcanized rubber by Witco Chemical Co., 295 Madison Ave., New York 17, N. Y.
- VACUUM METALS Corporation is a new company, the wholly-owned subsidiary of the National Research Corporation of Cambridge, Mass. It will undertake the production of vacuum cast gas free metals and alloys.
- THE QUESTION "What's a Silicone?" is answered in an illustrated booklet with that title put out by the Dow Corning Corporation, Midland, Michigan.
- VALUABLE INFORMATION on the properties and reactions of hydrogen peroxide is given in the 26-page bulletin No. 36, "Progress in Peroxides," available on request from Buffalo Electro-Chemical Co., Inc., Station B, Buffalo 7, N. Y.
- CALCIUM SILICATE, insoluble and non-toxic, is claimed to be the answer to dampening and caking of salt in hot weather. Salt containing this additive is being marketed under the name "Weather-pruf" by the makers of Diamond salt, distributed by General Foods.
- THE FOLINIC acid group of growth factors is featured in the 1952 No. 1 issue of Research Today, published by Eli Lilly and Co., P.O. Box 618, Indianapolis 6, Ind.

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THE

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